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U.S. RADIO FARM SCHOOL



U.S. DEPARTMENT OF
AGRICULTURE

OFFICE OF INFORMATION—RADIO SERVICE

Dairy Short Course No. 1

DAIRY HERD IMPROVEMENT

October 8-November 26

1926



*By J. C. McDOWELL, of the
Bureau of Dairy Industry*

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WGY---	{ 6.20 p. m., Monday and Friday. 6.45 p. m., Wednesday.
WLS----	6.15 p. m.
WCCO--	7.30 p. m.
WOS----	7 p. m.
KFKX--	7.15 p. m.
WLW---	1.40 p. m.
WHO---	2.15 p. m.
KFXF--	7.15 p. m.
KHQ---	5.30 p. m.
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KOIL---	7 p. m., Monday, Tuesday, and Friday.
KQW---	6.35 p. m.
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KTHS--	12 m.
KVOO--	11.30 a. m.
KWCR--	8.55 p. m.
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WCSH--	7.30 p. m.
WDAY--	7.30 p. m.
WEEI--	1 p. m.
WEW---	5 p. m.
WGHP--	6.40 p. m.
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*By J. C. McDOWELL of the Bureau of
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This is the first group of printed lessons supplementing the U. S. Radio Farm School talks from broadcasting stations listed on inside of cover. All regularly enrolled students in the livestock, poultry, and dairy sections will be furnished the full series of booklets. These publications are mailed at the completion of each short course



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(II)

DAIRY HERD IMPROVEMENT

Lesson 1. Culling Unprofitable Cows

It is safe to say that about one-third of our dairy cows are being kept at a loss, that one-third yield little or no profit, and that the profits of the dairy business come almost altogether from the other third. In many dairy herds the profits of the highest producers just about offset the losses of the lowest producers.

One farmer says that when he started keeping individual cow records he was the owner of 14 cows. The first year's records showed that 7 of his cows were very profitable and that 7 were decidedly unprofitable. This farmer says that his herd reminded him of the Hebrew-Egyptian story of the 7 fat years and the 7 lean years, for as the 7 lean years ate up the 7 fat years, so his 7 poor cows ate up the profits the 7 good cows made. Seven was the exact number of cows that were sent from that farm to the butcher.

That farmer did intelligent culling. He waited until he knew the record of each cow in the herd, and then he took action. The day the seven unprofitable cows left for the butcher was the day profits began on that dairy farm. Close culling changed a losing proposition into a winning one.

Cull the Low Producers

Nobody would advise that one-third of our dairy cows should go at once to the butcher because of low production. Such action would make a great milk shortage. There is no doubt, however, but that the culling of low-producing dairy cows should be much more severe than it has ever been.

This culling should not be done blindly, and it should not be based on guesswork. Keeping feed records and weighing and testing the milk regularly make it possible to determine the production of your

cows with a high degree of accuracy. From these figures the herd may be culled according to known production.

How closely the herd should be culled will depend on many factors, such as cost of feed, cost of labor, and price of product. As a rule, however, for most conditions and for most parts of the country the first culling should get rid of all cows that do not, at maturity, produce at least 6,000 pounds of milk containing at least 240 pounds of butterfat. For immature cows the records may be figured approximately to maturity by dividing the records of the 2, 3, and 4 year olds by 70, 80, and 90 per cent, respectively.

There is no reason in the world why dairying should ever be conducted at a loss on any dairy farm over any considerable period of time. Losses can be avoided by sending all the loss producers to the butcher. Of course, this will reduce the size of the herd, but as the low producers are sold profits will go up.

Suppose all Your Cows are Unprofitable

Occasionally there is a herd in which every cow is unprofitable. What is to be done with such a herd? The owner has a choice of two courses: Either he may use good sires and gradually build up a better herd, or he may send his whole herd to the butcher. If he does the latter, he should buy only good foundation stock.

It is rarely the case, however, that a herd of 10 or 12 cows is made up entirely of unprofitable cows. In studies made of thousands of cow-testing records by the Bureau of Dairy Industry it was found that, as a rule, the best cow in the poorest herd was a higher producer of both milk and butterfat than the poorest cow in the best herd. To be sure, these were herds much above the general average in production, but the difference between the best and the poorest cow is very great in almost every dairy herd. Therefore, close culling will rarely eliminate a herd, but it will almost always make it possible

for intelligent feeding to put the herd on a paying basis.

The low-producing culls should go to the butcher. They should not be sold to some other dairyman. One cow tester reports that it is easy enough to detect unprofitable cows, but that it is not so easy to induce the owner to send such cows to the butcher, especially if they will sell for a higher price as milk cows. To be sure, the culls from some very high-producing herds are comparatively high producers. Such cows should not be sent to the butcher but should continue to produce milk in somebody's dairy herd. As a rule, however, it is best that the culls should go to the butcher.

If the dairy herd is culled intelligently on the basis of individual cow records, if the remainder are fed according to known production, and if only good purebred sires are used, almost any dairy herd, regardless of its condition at the start, will eventually be placed on a paying basis. Successful dairying depends on many factors. Among these, culling is one of the most important. The most successful dairymen closely cull their herds.

Lesson 2. Selecting Animals for the Foundation Herd

Intelligent selection of dairy animals is the first step in building up a high-producing herd. It includes the selection of the sire as well as the cows. As time passes it also includes the culling of all animals that prove unprofitable; but in this brief talk we shall confine ourselves to the discussion of the foundation herd. Whether or not a dairy herd will be profitable from the very first depends largely on the selection of the foundation stock.

Most dairymen begin the business with very little capital. Because of this many of them think they can not afford to buy high-producing cows. Some even go to the extreme of buying low-producing scrubs because such cows are low in price per head.

It is true that the beginner who is short of funds must guard his cash with care. He could not buy

champions of production even if he wished, because his entire financial resources would perhaps be large enough to pay for only a small fraction of the cost of a cow of that type. He must be content to buy within the limits of his pocketbook, but that is no reason why he should go to the other extreme and purchase low-producing scrubs. A cow that does not produce enough to pay for her feed and care is not a cheap cow to own. Actually such a cow is dear at any price.

Begin with a Few High Producers

It is always better to begin dairying with a small herd of comparatively high-producing dairy cows than with a larger herd of low producers. The high producers are really not much more expensive than the scrubs.

What do we mean by comparatively high-producing dairy cows? The expression "high producing" does not mean the same to every dairyman. To the owner of a scrub herd it may mean a butterfat production per cow of 150 pounds a year. To the owner of a good purebred herd it may mean three or four times that much. The man of limited resources who is about to go into the dairy business should set a minimum standard of production for a mature cow at not less than 6,000 pounds of milk containing at least 240 pounds of butterfat.

But how does anyone know what a dairy cow produces before he buys her? A few years ago there was no practicable way of knowing this, but now, thanks to the work of more than 800 cow-testing associations, about 350,000 dairy cows are on yearly test in this country. This test shows for each cow the yearly production of milk and butterfat, cost of roughage, cost of grain, gross income, and average income over cost of feed. These records are kept by an impartial tester and serve as a guide in selecting the foundation stock for the new herd.

Even the sire may be selected through the cow-testing association by means of the records of his daughters. It is not yet practicable, however, to select many bulls on this basis, because not many

have been proved through these records or through those of the advanced registry. At the present time most dairy sires must be selected on appearance, pedigree, and the records of the dam.

If dairy cows for the foundation herd are bought on their cow-testing association records, the purchaser may acquire a herd of known producing capacity, but that is not enough. The age of each cow and her physical condition may be of even greater importance than her ability to produce milk. If a cow is very old, if she is a nonbreeder, or if she has tuberculosis or infectious abortion, she is not to be considered in selecting animals for the foundation herd.

Minimum Requirements for Foundation Stock

Young, healthy, well-bred dairy cows that produce over 6,000 pounds of milk a year containing more than 240 pounds of butterfat should prove satisfactory in every way as foundation stock on which to build your future herd. Of course, if production records can not be obtained it will be necessary to choose cows on their appearance, or, in the case of purebreds, on their appearance and their pedigree.

One of the cheapest ways so far as the immediate outlay is concerned is to buy a few bred heifers, or heifers about to freshen. In this case the breeding of the sire and the production record of the dam are very important. Beginning with young unbred heifers or with heifer calves will require too much time for one who is interested in immediate returns. By starting with cows in milk the owner may have an income from the dairy herd in the form of dairy products the very day he buys his first cow.

Some will ask, "What breed should I choose?" In reply we would say, "Other things being equal, select the one you like best." There is no best breed of dairy cows. Good cows and poor cows may be found in any breed. It is not especially important which breed you select, but it is all important that you select good individuals of the breed.

In deciding on the breed, however, it is usually best to choose one that is common in the neighbor-

hood. If buyers desire to purchase animals of a particular breed, they are almost certain to go to a district where many animals of that breed are to be found. One farmer started with a breed not previously found in his community. He expected to have a monopoly of surplus stock of that breed in that district. He did have a monopoly, but the trouble was that buyers of that breed of cattle did not go into that neighborhood at all because there were not enough animals of that breed there.

Better Generally to Begin with Grades

Regarding purebreds and grades, records show that the purebred cows of this country produce more milk and butterfat per cow than is produced by grades; yet, as a rule, the beginners had better start with grades. In beginning with purebreds the initial cost will be higher, the care and management will require more knowledge and skill, and, on account of greater value, the risk of heavy loss will be greater. After making a success with grade cows, the dairyman may desire to change to purebreds. This he may do gradually at little expense for foundation stock by buying two or three good registered females.

Immediate success in dairy farming depends upon a wise selection of the foundation stock. Cows of low natural ability to produce milk are seldom profitable under any conditions. A farmer starting a dairy herd can not afford to use such animals even if there is a prospect of improvement of the offspring through intelligent breeding and selection.

If the start is made with low producers, profits can not amount to much until a better herd has been built up through the use of good sires and the weeding out of low producers through testing. The building of a high-producing herd from a herd of scrubs, through breeding, requires much time. The typical American farmer does not want to see profits too long deferred.

Regardless of how large the herd may be or how carefully it is fed and handled, there is little chance for success in a dairy with cows that lack the inherent ability to produce reasonably large quantities

of milk or butterfat. Therefore the dairyman should be careful to choose good animals as the foundation stock for his dairy herd.

Lesson 3. Better Cows from Better Sires

The selection of dairy animals for the foundation herd and a long-continued culling of low producers as the herd increases in number are two big steps toward profitable dairying. These two steps, however, will make a sorry showing unless supported by intelligent breeding.

The choice of a sire to head the dairy herd has long been considered of prime importance. For some time scrub and grade bulls have been positively condemned by all good dairy-cattle breeders. These men recommend the use of only purebred sires of first-class pedigree, thus getting rid of even the purebred bull whose ancestry is unsatisfactory.

Pedigree indicates but does not prove a bull's true value. To prove his value requires that the production records of his daughters be compared with the records of their dams. Dairy bulls are rare whose daughters all excel the records of comparatively high-producing dams, but some have been found.

Make Use of Production Records

Dairy records have furnished production figures for the daughters of a large number of purebred dairy sires. In some cases every daughter produced more than her dam; in some cases every daughter produced less than her dam; and in a large number of cases some daughters excelled their dams and others did not. For a long time individual cow records have been used in culling the low producers and in determining what and how much the others should be fed. Now they are also being used to prove the breeding value of the sires.

These records are taking the guesswork out of dairying. First they get rid of guesswork in con-

nection with the selection of cows. Next they get rid of guesswork in the selection of sires. If every one of the first five daughters of a certain sire produces considerably more than her fairly high-producing dam, it is probable that the sixth daughter will do likewise. If every one of the first 10 daughters of a certain sire produces considerably more than her fairly high-producing dam, it is almost certain that the eleventh will do likewise.

A tabulation of the production records of the daughters of a hundred sires furnished the following examples:

In the case of one sire having five daughters, every daughter excelled her dam in production of both milk and butterfat. On an average the dams produced 10,651 pounds of milk in a year and the daughters 16,364 pounds. On an average the dams produced 351 pounds of butterfat and the daughters 588 pounds. The daughters excelled the dams by an average of 5,713 pounds of milk, or 53.6 per cent, and by 237 pounds of butterfat, or 67.5 per cent.

In the case of another sire having 10 daughters, every daughter produced less than her dam. On an average the dams produced 9,676 pounds of milk a year and the daughters 4,825 pounds. On an average the daughters produced 4,825 pounds, or 50.1 per cent, less milk than the dams. The dams produced an average of 499 pounds of butterfat and the daughters 290 pounds. The daughters produced 209 pounds, or 41.9 per cent, less butterfat than the dams.

A Great Difference in Sires

These figures show that there is a great difference even in purebred dairy sires. If we are to breed for better cows through the use of better sires, we might as well substitute certainty for uncertainty. Through the use of proved purebred sires any dairy herd may in a few generations be brought to a high level of production.

To bring this about on a large scale, however, large numbers of bulls must be proved. That means that the bulls must be kept until the daughters have been tested for production. By the time half a

dozen daughters have been tested the bull will be 5 or 6 years old, and by that time he may be cross and hard to handle. Therefore, he must be kept in a strong pen so built that the owner will never be in danger.

To be sure, great progress has been made toward dairy-herd improvement through the use of purebred bulls of good pedigree. The earliest cow probably produced only milk enough to feed her calf until it could forage for itself. The well-bred cow of to-day produces enough milk to feed a dozen calves. Selection, feeding, and breeding are the chief factors that have brought about these results. The most rapid improvement has come in recent years. Though improvement has been rapid there is still room for more. Such improvement must come, in large part, through the breeding of better cows to better sires.

Lesson 4. Butterfat and Income

Everybody who milks cows knows that the cows that produce a great deal of milk are the ones that bring in most of the profits. Few people, however, realize how rapidly the income goes up as production increases.

A study of more than 20,000 yearly individual cow records not only showed a definite relation between production of butterfat and income over cost of feed, but it actually measured the rate at which income over cost of feed advanced as butterfat production increased from group to group.

The group that had an average yearly butterfat production of 100 pounds per cow had an average income above feed cost of \$10 a year per cow. The group that produced 200 pounds of butterfat per cow had an average income over cost of feed of \$42 per cow. At 300 pounds of butterfat per cow the income above feed cost was \$74, and at 400 pounds per cow it was \$106.

One Good Cow is Worth Ten Poor Ones

The cows that produced 400 pounds of butterfat a year produced four times as much as those in the

100-pound group, but they brought in 10.6 times as much income above feed cost. I would rather own 1 cow that produces 400 pounds of butterfat a year than to own 10, each of which produces 100 pounds.

A Virginia dairyman says that when he began testing for production he had a herd of 31 cows. After weighing and testing the milk for a few weeks he reduced the number to 26. These he fed according to known production and obtained a higher total yield than had formerly been obtained from the larger herd. By the end of that first year of testing the number of cows was reduced to 20, and the 20 actually produced more than the original 31.

Through careful selection and close culling the herd was reduced to 10 well-bred, well-fed cows, and the 10 produced as much butterfat as the 20. The herd was then gradually built up in numbers until it consisted of 20 cows, and the 20 produced annually more than twice as much milk and butterfat and many times as much net profit as was produced by the original herd of 31 cows.

Herd records have been used in studying the relation of butterfat production to income over cost of feed. This study included the average production of each of 1,309 herds. The herds having an average production of 205 pounds of butterfat had an average income over cost of feed of \$41, and those whose average production was 391 pounds had an average income over cost of feed of \$93. The results were not so striking as when a comparison was made of the records of individual cows, because the records of the low-producing cows tended to offset the records of the high-producing cows in the same herd.

The Owner may be Surprised

Sometimes yearly individual cow records bring a great surprise to the owner. Occasionally they cause him to reverse his decision as to the profitableness of certain cows in the herd.

Before a certain Missouri farmer began testing his cows for production he owned a good herd in which was an old crippled cow named "Goldie." At that

time the farmer was trying to sell Goldie for \$75 because he thought that was all she was worth. To his great surprise the milk scales and the Babcock test not only placed crippled Goldie at the head of the herd but proved her to be one of the highest producers in that region. Her yearly production, as shown by the records, was 9,300 pounds of milk containing 526 pounds of butterfat. Her income over feed cost that year was \$267. That means that the product was sold at a comparatively high price, but large production was the chief cause of high income above feed cost.

In one of the best dairy districts in Michigan in 1925 a certain farmer owned a herd of 15 low-producing dairy cows and one of his neighbors owned a herd of 10 high-producing dairy cows. The 15-cow herd had an average butterfat production of 239 pounds per cow, and the 10-cow herd had an average butterfat production of 429 pounds per cow.

More Than Three Times as Much Profit

The low-producing herd had an average income above cost of feed of \$35 per cow, and the other herd had an average income above feed cost of \$188 per cow. The total income above cost of feed for the 15-cow herd was \$525 and for the 10-cow herd it was \$1,880.

With two-thirds as many cows, the owner of the smaller herd received \$1,355 more income above feed cost. He spent more money on feed, especially on concentrates per cow, and he marketed the product at a higher price per pound of butterfat; but the big difference in income above feed cost per cow came mostly from the difference in production. Every dairyman should strive for larger economical production per cow because it is certain to result in larger financial returns.

In all the studies so far made of production records of individual cows these records have shown that for groups of cows high production is always accompanied by large income over cost of feed. On ordinary dairy farms it seldom happens that cows are

fed beyond the point of economical production. The relation between production and income is very definite and very constant. Large production and large income over cost of feed are almost always found together.

Lesson 5. Feed Cost and Income Over Cost of Feed

A study of tens of thousands of yearly individual cow records from dairy herds has shown that high production of milk and butterfat is always accompanied by liberal feeding. Some of the tabulations showed this relation to be very definite and constant.

In a study of 2,837 yearly individual cow records from the Central West it was found that the cows that were fed no grain had an average yearly butterfat production of 184 pounds; those that ate \$10 worth of concentrates in a year produced 239 pounds of butterfat; those that ate \$20 worth produced 275 pounds of butterfat; those that ate \$30 worth produced 296 pounds of butterfat; those that ate \$40 worth produced 329 pounds of butterfat; and those that ate \$50 worth produced 364 pounds of butterfat.

Not only did the production of butterfat go up with the cost of grain fed, but income over cost of feed also advanced at a rapid rate. The cows fed no grain returned to their owners \$58 income over cost of feed per cow. Those fed \$50 worth of grain returned to their owners \$144 income over cost of feed per cow.

Relation Between Feed Costs and Production

A dozen tables from several different districts of the West Central, Southern, and Eastern States gave similar results. Not enough records have yet been studied from the Western States to warrant conclusions for that territory on this subject. As cost of grain per cow went up from group to group average production per cow advanced, and this was accompanied by a greater income over cost of feed per cow.

There were, however, individual cows and some entire herds that were fed beyond the point of economical production. Some of these were fed so much in dollars' worth of feed per cow that the profits were apparently reduced through overfeeding. This was not the fault of the cows but the fault of the one who fed them.

Occasionally there was a herd that had a high cost of concentrates fed, a medium production, and a low income above feed cost. In the case of one such herd the profits were extremely low. Upon further investigation it was found that the herd was cared for by a man who dished up the grain with a scoop shovel and fed all the cows alike regardless of production. The result was disastrous. The scoop-shovel method has since been given up in connection with that herd and it is now on a profitable basis.

In some of the Western States an attempt has been made to cut the grain very low and to feed liberally of legume hay and silage. In some cases the results seem to have been quite satisfactory.

Replacing Grain with Legume Hay

Though the records so far studied show a close relation between a liberal grain ration, large production, and high income over cost of feed, the excessively high cost of feed in some districts indicates that more home-grown legumes might well be substituted for a part of the very high grain ration.

For practically every agricultural district there are dairy farmers who might increase greatly the net income from their dairy herds by growing and feeding more legumes. If this practice can be carried out in such a way as to cut the cost of feed without reducing the production per cow, it must result in a larger net income to the owner of the herd.

High production per cow can not be obtained without liberal feeding. It can not be obtained even with liberal feeding unless the cows are of high quality. A combination of good cows and intelligent feeding brings large profits. This was nicely illustrated in one Wisconsin cow-testing association that completed

its testing year in 1926. There were 27 herds on test in the association. Every herd except one had an average production of butterfat per cow of more than 300 pounds, and only one herd dropped below \$100 in average income over cost of feed per cow. The herd that fell below \$100 in income over cost of feed was the herd that fell below 300 pounds in production of butterfat.

Returns of Three for One

The cows in the entire association averaged 10,086 pounds of milk and 363 pounds of butterfat. On an average they returned \$146 per cow in income over cost of feed, and on an average they returned more than \$3 for every dollar spent for feed. The average price received for butterfat was slightly below 60 cents a pound.

This seems to be a case where every herd in the association was made up of good cows and was intelligently fed.

There are two factors in which every dairyman is vitally interested—returns from a dollar spent for feed and yearly returns in income over cost of feed per cow. Cow-testing association records always show that it pays to keep good cows and to feed them well.

Lesson 6. When Should Cows Freshen?

At what time of year is it most profitable to have cows freshen? This is a live question with most dairy farmers. There is a widespread belief that cows produce more milk and butterfat, and that they produce more economically, if they freshen in the fall or winter than if they freshen in the spring or summer.

A study of more than 10,000 yearly individual cow records shows that there is a definite relation between season of freshening and other factors, but that relation is not the same everywhere and under all conditions. The relation seems to depend to some extent on cost of feed, condition of pastures, and geographical location with reference to markets.

In our study of 10,000 yearly individual cow records the cows that freshened in the spring produced on an average 236 pounds of butterfat; those that freshened in the summer produced the same, or 236 pounds; those that freshened in the fall produced 268 pounds; and those that freshened in the winter produced 258 pounds.

Fall-Freshening Cows Most Profitable

In the production race the cows that freshened in the fall had a clear lead over all others. In production of butterfat they beat the winter-freshening cows by 10 pounds and the spring and summer-freshening cows by 32 pounds.

The figures showed that it cost a little more to feed the cows that freshened in the fall and winter than to feed the others, yet the fall and winter freshening cows won out on average income above feed cost. On an average the cows that freshened in the spring returned \$71 in income over cost of feed, those that freshened in the summer returned \$67, those that freshened in the fall returned \$77, and those that freshened in the winter returned \$76 in income over cost of feed. On an average all along the line the cows that freshened in the fall and winter won out.

It would appear from these figures at first glance as though we might safely recommend that the dairyman should have his cows freshen in the fall. We must not, however, be too sure about that. If nearly all our cows freshened in the fall, there would be an oversupply of dairy products in the winter and an undersupply in the summer. Profits would then be reversed and spring and summer freshening would win.

Anyway the figures given above do not show an overwhelming gain either in production or income above feed cost from the cows that freshen in the fall and winter. It would seem best, therefore, that the freshening of cows should be well distributed throughout the year with a preference for a large percentage of fall-freshening cows.

Locality Should be Considered

A further study of the records showed that in some sections the spring and summer freshening not only gave a higher production but a larger income above feed cost. Of the 67 sets of cow-testing associations studied on this subject 29 showed highest milk production for those that freshened in the fall, for 18 winter freshening won, for 10 summer freshening won, and for 7 spring freshening won. These figures do not total 67 because there were some ties.

For butterfat production the results were much the same. Fall freshening won 38 times out of a possible 67, winter freshening won in 13 associations, summer freshening won in 8, and spring freshening won in 7.

In income over cost of feed, the subject of most importance to the dairyman, fall freshening won in 30 associations, winter freshening won in 17, spring freshening in 9, and summer freshening in 8.

The Best Months to Have Cows Freshen

A further study in which the figures were tabulated by months showed that fall and early winter freshening won and that late winter freshening did not hold its own with the earlier dates. The months that took the lead in production and income over cost of feed were October, November, December, and January.

Although fall and early winter freshening won out according to these studies, the figures did not show any great margin in favor of any one month or of any one season. Quality of cow is vastly more important than season of freshening.

I would rather own a high-producing dairy cow that freshens in the spring or summer than to own a low-producing cow that freshens in the fall or winter. About all we can say in summing up is that, other things being equal, the cows that freshen in the fall and early winter have a slight advantage, generally, in production of milk, in production of butterfat, and in income over cost of feed.

Lesson 7. Comparison of Purebreds, Grades, and Scrubs

Some people think that grade cows produce more than purebreds, and occasionally we hear some one say that his old scrub cow Brindle will beat any purebred at the milk pail.

Undoubtedly some grades excel some purebreds, and some scrubs excel some grades in production of both milk and butterfat. But a careful study and comparison of the yearly production records of 48,097 purebreds, grades, and scrubs showed that in the production race the purebreds won, the grades were second, and the scrubs got third place.

The grades and scrubs, however, gave a very good account of themselves. It is well known that grades are culled much more closely than purebreds. Undoubtedly this culling had a great deal to do with the high average production of the grades.

Grade Herds are Culled Closely

Doubtless the cows rated as scrubs or natives consisted of the choice cows of the old scrub herd. The old herd had been culled in many cases until only one or two were left. Yet, on an average, these animals of no particular breeding could not hold their own in production when compared with cattle of better breeding.

Time will not permit the giving of many figures for comparison. At the age of 2 the grades excelled the scrubs in yearly milk production by 813 pounds per cow, and the purebreds excelled the grades by exactly the same quantity, 813 pounds. In income over cost of feed on the average the grades excelled the scrubs by \$15 a year per cow and the purebreds excelled the grades by \$12 a year per cow.

For older cows the figures held about the same relative proportion until the age of 10, when the grades, on account of very close culling, began to overtake the purebreds. The scrubs never overtook anything. Even if they did consist of Spot and Bess, the very topnotchers of the old scrub herd, they could not overtake the grades and purebreds.

Largest Eaters Produce the Most

At every age the purebreds ate more than the grades in dollars' worth of feed per cow and the grades ate more than the scrubs in dollars' worth of feed per cow, but the cows that ate the most produced the most, had the highest gross income per cow, and the largest average income over cost of feed.

At the age of 6 the purebreds excelled the grades in average yearly production of butterfat per cow by 20 pounds, and the grades excelled the scrubs by 36 pounds. On an average the purebreds ate \$16 worth of feed more than the grades and \$26 worth more than the scrubs. In income over cost of feed the purebreds excelled the grades by \$13 and the scrubs by \$33.

On an average for cows of all ages the purebreds produced 7,667 pounds of milk and 296 pounds of butterfat. Their feed cost was \$76 per cow per year, and on an average they returned \$93 in income over cost of feed. The grades averaged 6,999 pounds of milk, 281 pounds of butterfat, ate \$61 worth of feed, and returned \$83 in income over cost of feed.

A Margin for Purebreds

Those who are great believers in purebreds may be a little disappointed that the purebreds won by so small a margin, but they must not forget that the grades always have some purebred ancestors. These should be given credit for the high production of the grades. The grades having scrub ancestry four or five generations back may be well bred. The first cross with a purebred sire makes them half purebred, the next cross makes them three-fourths, and the next seven-eighths purebred.

Were it not for the fact that purebred sires have improved our herds we would still be busy milking scrubs. These would not be the carefully selected scrubs mentioned earlier. No; they would be the typical scrub that it is now a disgrace for any dairyman to own.

In one cow-testing association a scrub cow produced in a year's time 146 pounds of butterfat, her

daughter sired by a scrub bull produced 126 pounds, and her granddaughter sired by the same scrub bull produced 99.7 pounds. Her yearly record just about equaled the world's record for a goat.

When anybody tells you that scrubs produce more on an average than grades and that grades produce more on an average than purebreds, don't tell him that he is lying. Just tell him that he is mistaken. Then go ahead and build up a good grade or a good purebred dairy herd on your own farm.

Lesson 8. Cow-Testing Associations

The cow-testing association, as ordinarily conducted in this country, is an organization of about 26 dairy farmers who cooperatively employ a tester to keep production, feed, and income records of their dairy cows. Knowing the actual production and feed cost records of his cows, the dairyman can with certainty get rid of those that do not pay a profit and feed the remainder according to known production.

In cow-testing association work the tester spends a whole day on each farm once a month. He weighs the feed night and morning, takes a sample of each cow's milk night and morning, tests the mixed sample of the two milkings of each cow, multiplies the daily record by the number of days in the month, and records the monthly record in the farmer's herd book.

The tester discusses with the farmer the production and feed-cost records of the individual cow, and together they determine the feed they think she should have in order to increase the profits. The tester and the farmer also decide which cows should be kept and which should go to the butcher.

Twenty-one Years Old

The first cow-testing association in the United States was organized in Newaygo County, Mich., in 1905 and began work in January, 1906. Since then there has been a comparatively rapid and quite a constant growth. At the present time there are about

850 cow-testing associations in active operation and approximately 350,000 cows on test in these associations.

Are cow-testing associations accomplishing much in the way of increased production per cow? Most certainly they are. The records of cow-testing association cows tabulated previous to 1920 showed an average production of 6,077 pounds of milk and 247 pounds of butterfat. That production was about 50 per cent above the average of all dairy cows in this country. Since then the average production of cow-testing association cows has been increasing.

A tabulation of 64,169 yearly individual cow records for the testing years ended in 1924 and 1925 showed an average milk production of 7,272 pounds and an average butterfat production of 282 pounds. This is a big gain in a short time. If all our cows produced as much as the cow-testing association cows, we would not need so many of them.

Early Years Show Greatest Gain

In a well-managed cow-testing association the gain in average production per cow is quite rapid during the first four or five years of association work. From that time on the gain may be less rapid, because it is much easier to raise production from a low level to a higher level than to raise production from a high level to a still higher level. Figures from three associations for a period of the first five years after organization showed the following results:

Year	Butterfat average per cow (pounds)
1-----	237
2-----	255
3-----	278
4-----	292
5-----	305

Between the first and fifth years the production per cow in these three associations jumped from 237 pounds of butterfat to 305 pounds. These figures are averages for all the cows in three associations. The gain per cow in individual herds was, in some cases, much more than that.

The cow-testing association work helps both low and high producing herds. When the first Minnesota cow-testing association was started near Albert Lea in 1910, the lowest producing herd on test consisted of 30 cows having an average butterfat production of 112 pounds. Four years later the herd had been reduced to 20 cows having an average butterfat production per cow of 228 pounds. With two-thirds as many cows the herd was producing one-third more butterfat.

The first year the highest producing herd in that association consisted of 22 cows having an average butterfat production of 311 pounds. Four years later the same herd consisted of 25 cows having an average butterfat production of 400 pounds. Here was a production gain per cow of a little more than 28 per cent.

It will Pay Any Dairyman to Join

From these figures it would seem wise for a dairyman to join a cow-testing association regardless of the quality of his herd. The testing enables the owner to cull his herd intelligently, to breed intelligently, and to feed according to known production. In other words, it may be said that the work substitutes certainty for guesswork.

The cow-testing association slogan should not be "More cows" but "More good cows."

The following quotations are from what farmers have said regarding cow-testing association work. One farmer said: "The first year I belonged to the association my herd of 10 cows produced an average of 279 pounds of butterfat, with an average income over cost of feed of \$37. The fifth year my herd, which then consisted of 17 cows, produced an average of 380 pounds of butterfat, with an average income over cost of feed of \$82."

Another farmer expressed himself in these words: "The work of the cow-testing association has increased the cream checks \$250 a year from my 12 cows."

Another farmer interested in the cooperative features of the work said: "What a change since the

association was organized! Now we cooperate in buying feed, in hauling cream, and in holding public sales of tested cows. Every member grows alfalfa, keeps a purebred dairy sire, and raises the best of the heifer calves."


Test Bulls as Well as Cows

Heretofore the cow-testing association work has been confined largely to the testing of the cows. Now it is testing the sires also through the records of their daughters. It takes a little longer to obtain the records that condemn or approve the sire, but they are just as definite and exact in the conclusions one may draw from them.


Not only are the cow-testing associations accomplishing much for the farmers and for the industry, but they are gaining in popularity. Reports received about July 1, 1926, showed a gain of about 75 in the number of new associations during the preceding six-month period. The work is bringing great results, and it should grow. This gain is coming largely through the activity and influence of the State dairy extension specialists. For information regarding the organization and management of cow-testing associations write to the extension department of your own State agricultural college.



In 3526
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U.S. RADIO FARM SCHOOL



U.S. DEPARTMENT OF
AGRICULTURE

OFFICE OF INFORMATION—RADIO SERVICE

Dairy Short Course No. 2

BETTER MILK PRODUCTION

October 8–November 26,
1926



*By Specialists of the Bureau of
Dairy Industry*



Washington :: Government Printing Office :: 1926

Radio Stations Broadcasting the U. S. Farm School

(Scheduled on Monday, Wednesday, and Friday, unless otherwise specified)

WGY---	{6.20 p. m., Monday and Friday. 6.45 p. m., Wednesday.
WLS----	6.15 p. m.
WCCO--	7.30 p. m.
WOS----	7 p. m.
KFKX--	7.15 p. m.
WLW---	1.40 p. m.
WHO---	2.15 p. m.
KFXF--	7.15 p. m.
KHQ---	5.30 p. m.
KMA---	11 a. m.
KOIL---	7 p. m., Monday, Tuesday, and Friday.
KQW---	6.35 p. m.
KTCL--	8 p. m., Monday, Thursday, and Friday.
KTHS--	12 m.
KVOO--	11.30 a. m.
KWCR -	8.55 p. m.
WCAE--	7.10 p. m.
WCSH--	7.30 p. m.
WDAY -	7.30 p. m.
WEEI--	1 p. m.
WEW---	5 p. m.
WGHP -	6.40 p. m.
WLBL--	12.30 p. m., Monday and Wednesday.
WOOD--	7.35 p. m.
WSM---	
KFBB--	1.30 p. m.

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*By Specialists of the Bureau of
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This is the second group of printed lessons supplementing the U. S. Radio Farm School talks from broadcasting stations listed on inside of cover. All regularly enrolled students in the livestock, poultry, and dairy sections will be furnished the full series of booklets.

These publications are mailed at the completion of each short course



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(II)

BETTER MILK PRODUCTION

Lesson I. The Desirability of Clean Milk

ERNEST KELLY

We are living in an age of greatly improved sanitation. This has resulted in longer and healthier lives and has been largely brought about by increased care in guarding against preventable diseases. The wheel of science has turned rapidly, almost dazzling us with a constant succession of brilliant achievements.

Malaria, yellow fever, plague, typhoid, and other diseases have been successfully fought within a generation. The infant death rate has been decreased, and a very great many happy, healthy children are alive who would never have survived under old conditions.

Improvement in our national food supply has been a strong factor in prolonging life and preventing sickness. We have not only learned how to select and prepare foods more usefully, but we have also learned how to produce and keep foods in a more sanitary manner.

A Great and Useful Field

The production of clean milk for human food is one of the greatest and most useful fields for farmers. Nearly half of the milk produced in the United States is used in the fluid form, either as milk or cream. The magnitude of this life-giving torrent is indicated by the fact that over 54,000,000,000 pounds of fluid milk and cream were consumed in 1925. Man and woman, farm and factory, sick and strong—all were benefited by this universal food beverage.

The importance of milk drinking has long been recognized, but only in the last few years has research demonstrated the need so forcefully that the general public has waked up and demanded more of its share.

Naturally enough, milk consumers and those charged with the protection of food supplies have insisted that milk be produced and handled under sanitary conditions. Knowledge of sanitation has also increased, and we know many new methods that must be used to produce clean milk.

Thus modern milk production carries increased responsibilities and necessitates greater skill and some added expense. If milk is carelessly produced and improperly handled, it may be the means of spreading disease. Every dairyman should realize this and recognize the duty he owes to his family and to the community in providing only clean, wholesome milk.

Responsibility Rests Upon Everyone

Milkers and milk handlers should recognize the fact that they are dealing with a food product which is easily contaminated and should take all reasonable precautions to prevent conditions arising which may make milk unfit for human consumption.

The consumer in the city is entitled to this protection because he buys the milk and is warranted in demanding milk of a high standard if he pays the price for it. He should consider clean milk as a paying investment not only for its food value but as health insurance.

Dairymen also should be alive to the welfare of their own families. Although the milk problem on the farm is much simpler than that in the cities, the same benefits arise from a clean milk supply. Farmers' families are just as much entitled to wholesome and abundant food supplies as are their city cousins. The best is none too good for them. Every dairyman furnishing clean milk to others has the satisfaction of knowing that his own family is benefiting also.

Clean Milk Makes More Dollars Jingle

Aside from any question of health, clean milk is a sturdy plant that bears valuable fruit like the legendary tree with the golden apples. The production of better milk has brought many dollars into the dairymen's pockets. The reasons for this are that there is less actual loss through spoiled milk and that there is an increased demand at better prices for high-grade dairy products.

Insanitary practices in the dairy add many bacteria to milk, and lack of proper cooling allows these bacteria to increase rapidly in numbers. Bacteria are tiny plants, and, if sown in the fertile field of milk, grow under favorable conditions and produce an enormous crop. Like other plants bacteria grow more rapidly when kept warm, but are dormant or nearly so when cold.

In market milk bacteria may be classed as the weeds of plant life. Although not all kinds produce disease, every variety is undesirable. Some cause sour milk, whereas others cause changes which result in unpleasant flavors and odors.

It is possible to estimate the loss to farmers which comes through the action of bacteria in milk. Nearly all modern milk-receiving stations and milk plants return sour or off-flavored milk to the farmer, or pay for it at reduced rates. One milk plant at which records were accurately kept returned over 50,000 gallons of sour milk to farmers in one year.

If the dairyman delivers milk of poor quality directly to consumers, his shame is still keener and his loss usually greater, for besides losing the sale on that particular lot of milk he may lose a customer.

Effect on Milk Consumption

Another angle to the situation is the effect on milk consumption. It has been definitely proved that the consumer will use a greater quantity of dairy products if they are of good quality and flavor. This proposition needs little proof, as it is really self-evident. Would you eat more sound, mealy potatoes

than you would soggy, specked ones? How about rancid fat for cooking as compared with clean, fresh fat? Of which would you consume the more, corn bread made from sound, clean grain or from musty meal?

Apply the same reasoning to milk, and you will arrive at an answer which will represent the trend in milk consumption. The use of milk in this country has increased considerably during the last few years, and this increase has undoubtedly been stimulated by the improved quality of milk which our dairymen have been furnishing.

Don't forget that supply and demand are still working in the milk business. If you want to increase your output at the best prices obtainable, be sure that you supply high-quality milk and cream.

Lesson 2. General Considerations in Producing Clean Milk

ERNEST KELLY

In the production of clean milk there are many things to be considered—so many that sometimes confusion exists as to just what is essential. On the one hand there are those who place undue emphasis on certain things which have little bearing on the quality of the milk; while on the other hand, some disregard everything except a few factors which have the greatest bearing on the actual number of bacteria in milk. Neither extreme is advisable or just.

Measures must be taken in milk production which will fully protect the farmer from losses and the consumer from impure milk. It is advisable to go even beyond this and to add certain touches which perhaps will not yield returns in lowered bacteria counts.

Why Produce Clean Milk

This is desirable for two reasons:

(1) Clean surroundings and orderly methods stimulate cleanliness and care in those who work about

the dairy. It has been said that a clean man could produce clean milk amid dirty surroundings if he used careful methods. This is undoubtedly true, but a clean man is apt to lapse into carelessness himself if he works long in a dirty place. As a matter of fact, clean milk is very generally produced in clean dairies, and while there may be exceptions, they "prove the rule."

(2) The consumption of milk has increased rapidly, and there is no doubt but that this increase has been due in a large part to the confidence the consumer has placed in the quality of our modern milk supply. It well behooves dairymen to retain this confidence by keeping their houses in order, so to speak.

Major Factors in Producing Clean Milk

Factors in the production of clean milk may be divided into two general classes—the major and the minor. Among the major factors are clean, healthy cows; small-top milking pails; sterilized utensils; and proper cooling and storage of milk.

The first essential in producing clean milk is healthy cows. Animals affected with tuberculosis, garget, and other diseases which may contribute dangerous bacteria to milk or cause abnormal physical conditions are not fit to produce milk for the market or home consumption. The cow's body, especially the udders, teats, and flanks, should be clean. If necessary, wash and wipe them or wipe them with a clean, damp cloth before milking.

Small-top milking pails are inexpensive and prevent much dirt from dropping into the milk during the process of milking.

Sterilized utensils and proper cooling and storage of milk are such important aids in keeping bacteria counts low that they will be treated separately in later broadcasts in this series.

Minor Factors in Producing Clean Milk

The so-called minor factors in clean-milk production have to do largely with the surroundings where milk is produced and handled on the farm.

Barn construction may be simple and inexpensive and at the same time well suited for producing high-quality milk. Smooth, tight walls, ceilings, and floors are easily built and greatly aid in keeping the cow stables clean. The floor should be tight and of non-absorbent material, so that liquid manure will not leak through.

Sunlight and fresh air are two important items in sanitation. They also promote good health in cattle and make barn work more pleasant. Four square feet of window glass for each stanchion, evenly distributed, is not too much.

In cold climates it is necessary to provide some method of changing the barn air so that the cattle may have a constant supply of fresh air without being subjected to drafts. Write for Farmers' Bulletins No. 1342, Dairy Barn Construction, and No. 1393, Principles of Dairy-Barn Ventilation.

Of course such a barn should be kept clean—manure removed at least once a day and a coat of paint or whitewash applied whenever necessary to the walls and ceilings.

The barnyard is worthy of attention. It should be graded and drained and kept free from accumulations of manure. This will lessen the work of cleaning the cows before milking.

Milk House Needed

After milking each cow it is very desirable to remove the milk to the milk room or milk house. This building need not be far from the barn. In fact, convenience suggests that it be close to the barn, with a separate outside entrance. Suggestions regarding barn construction also apply here.

Simple, smooth construction is all that is needed. Light and ventilation are necessary. Floors should be pitched to well-trapped drains which carry the drainage away from the building. Of course the ever-present fly may be kept out by screens and screen doors. No proper milk house is complete without

facilities for washing and sterilizing utensils and cooling and storing milk.

Having such a nice milk house, wouldn't it be a shame to spoil it by cluttering it up with old clothing, shovels, and odds and ends? Farmers' Bulletin No. 1214, Farm Dairy Houses, contains plans to suit most conditions.

Pure Water Must be Supplied

A pure water supply is a boon on any farm, but what a necessity on a dairy farm! Cattle are entitled to drink their fill of clean, fresh water instead of being forced to drink from mud holes or stagnant ponds. Dairy utensils should be washed in as clean water as the household plates, for are they not also food containers?

Milking machines are used on many farms, and they must be carefully cleaned if they are expected to give satisfactory results from a sanitary standpoint.

One final word about the care of milk between the farm and the receiving station, railroad, or city plant: An even temperature above freezing and below 50° F. should be maintained for best results. Frozen milk is not satisfactory to the buyer because its physical characteristics are not the same when it is thawed out.

We all know that milk which becomes warm allows bacteria to grow and often results in spoilage. Protect cans from extremes of temperature while hauling—blankets in winter and a cover from the sun in summer. This summer protection may be either a canvas or blankets which fit snugly over the cans.

Not so difficult, is it? Perhaps you're already doing these things. If you are, tell your neighbor what a satisfaction it is. If you're not, try it once and see for yourself. Farmers' Bulletin No. 602, "The Production of Clean Milk," tells the story in greater detail. Send for it.

Lesson 3. Sterilizing Milk Utensils

R. J. POSSON

If it were not for bacteria, milk of high quality would be much easier to produce and would keep longer even though carelessly handled. Bacteria, which are very minute single-celled plants that can not be seen with the naked eye, cause milk to sour and to deteriorate in other ways. An important factor in preventing a high bacteria content in milk is to avoid contaminating it. Milk as it comes from the normal cow's udder contains very few bacteria.

There are many ways in which bacteria may get into milk, but the most common and greatest source of all is unclean and unsterilized utensils. A utensil which has not been washed may have billions of bacteria on it and naturally is not fit to be used for milk. But even though utensils have been washed, their surfaces are apt to be teeming with bacterial life.

Most of these bacteria have a decidedly detrimental effect on the quality of the milk. From a commercial standpoint sour milk may usually be considered a total loss, and in the end this loss must usually be borne by the producer.

Mere Washing is not Enough

Milk utensils should always be washed before milk is placed in them. This is a matter of cleanliness upon which people would agree even though they have no knowledge of scientific methods of producing and handling milk. Dairymen who have had experience in producing milk which keeps well, however, know that washing the utensils is not enough, but that the equipment must be treated in some way to kill the bacteria which still adhere to the seemingly clean surfaces. To prevent these bacteria from being washed off in the milk, where they act as seed for the growth of many more, the utensils must be sterilized to kill practically all the bacteria.

It must be understood, however, that although merely washing the utensils is not sufficient to prepare them for milk, they must be washed before they are steamed. Otherwise, effective sterilization will not be obtained, and the accumulation of milk and foreign matter on the utensils will make them insanitary and unsightly.

As soon as possible after milk utensils are used and before they are placed in the wash water they should be rinsed inside and outside with cold or lukewarm water to remove loosely adhering milk and foreign material. They should then be thoroughly washed in hot water containing a soda ash or other nonsoapy alkaline washing powder.

Scrub with a Stiff Brush

The utensils should be scrubbed with a stiff brush instead of rags. A rag tends to smear grease and dirt instead of loosening it. Tubs or vats should be provided for use in washing the utensils. A wash vat divided into two compartments is convenient for this purpose. One end of the wash vat or sink is used for wash water and the other for rinse water, for after the utensils are washed they should be rinsed in clean pure water before they are scalded or steamed.

The sterilization process to which milk utensils are usually submitted kills practically all the bacteria they contain. The pathogenic or disease-producing types of bacteria are all killed if the utensils are thoroughly steamed or dipped in boiling water.

If only a very small number of utensils are used in a dairy, they may be sterilized by dipping them in boiling water or by pouring boiling water over them so that it comes in contact with their entire surfaces. Small utensils and bottles, if not too great in number, can easily be placed in water, which is then brought to a boil, thus sterilizing them effectively. When dairies are of considerable size, however, this proves to be a laborious and impractical process on account of the size and number of utensils.

Use Boiling Water

Water with which utensils are scalded must be boiling hot to be effective. The method sometimes used of rinsing one utensil after another by pouring water from one to the next one does not sterilize them. By the time the last ones are reached the rinse water which was boiling hot to start with has become cooled and so heavily infested with bacteria that it may leave more bacteria in the last utensils rinsed than it takes out.

Usually the easiest and most effective way of using heat to kill the bacteria on dairy utensils is to steam them in a tight cabinet. Sterilizing cabinets may be operated with or without a steam boiler, depending upon the needs of the individual dairy or the preference of the dairyman.

Steam Cabinets are Effective Sterilizers

Small retail and even medium-sized wholesale dairies which are not equipped with steam boilers may make very effective use of a galvanized-iron box steam sterilizer which may also be used to heat water. This box or cabinet may be made by any good tinsmith at reasonable cost. It may be placed on a foundation which serves as a fire box or may be set on any kind of a stove. Its shape and size may be varied to suit the convenience of the dairyman.

The utensils are placed in the sterilizer, and a small quantity of water in the bottom of it is boiled until the temperature of the box is approximately the same as the boiling water for a few minutes. A thermometer is inserted in a hole in the lid of the box so that there will be no need of guessing about the temperature which has been reached. A galvanized-iron box sterilizer operated in this manner gives very satisfactory results.

Sterilizing cabinets for dairies which have steam boilers may be constructed of galvanized iron, wood, brick, stone, hollow tile, or concrete. If material which is apt to absorb heat readily is used, it is well to insulate the cabinet on the inside, as this will

save time and steam. The utensils should be steamed until the temperature of the cabinet, as ascertained by a reliable thermometer, has been above 200° F. for five minutes.

It is very desirable to dry the utensils in order to prevent the growth of bacteria after the utensils are steamed and to prevent rust. Therefore these cabinets should be equipped with steam pipes to act as radiators to dry the utensils. This requires little steam and is well worth the expense of installing the steam-pipe coils.

Steaming Pails and Cans

Utensils, such as pails and cans, may be steamed effectively by inverting them over a steam jet until they are thoroughly heated. They should be steamed until they are entirely too hot to handle with the bare hands. Small objects, such as separator parts, may be piled around the steam jet and a tight box inverted over them. Large equipment, such as milk coolers and bottlers, which can not be put in the sterilizing cabinet, may be sterilized best with boiling water. This is much more effective than shooting steam with a steam hose at such equipment.

If all milk equipment and utensils are subjected to sufficient heat, they will not contaminate milk. This is exceedingly important if milk containing few bacteria and having good keeping quality is to be produced.

The United States Department of Agriculture has for free distribution Farmers' Bulletin 1473, entitled "Washing and Sterilizing Milk Utensils." If you need information on this subject write for one.

Lesson 4. Cooling and Transporting Milk

R. J. POSSON

The idea of keeping food cold in order to prevent it from spoiling is not new. Our grandparents and theirs before them knew that most foods would keep longer if kept as cool as possible. For this purpose

cold-water springs, when available, were utilized. The use of the old spring house for keeping foods cold is almost as old as history itself.

Where springs were not available, caves were dug and cellars built under houses in order to have a cool place to store perishable foods. As long as any of us can remember, when we had exceptionally perishable foods, such as milk and cream, to keep on the farm we hung them in the cistern or well. We may not have known why the milk kept better if kept cold, but we did know that if we did not keep it cold it soured in a few hours.

This same principle still holds true. The only difference is that since it is now necessary to transport milk and cream for greater distances it becomes necessary to use still more care in cooling these products and in keeping them cold. If this is not done, they sour and the producer suffers a loss.

Cool Milk Thoroughly Before Shipment

As the populations in our cities have increased, it has become necessary to cool milk more thoroughly on account of the long distances it must be transported. We have learned to make more effective use of our cold water and ice through modern methods and inventions. Also we are better informed through investigations about why milk sours when it is kept warm and why low temperatures prevent this.

If one has knowledge of his subject, it is easier to accomplish results, and in this respect we are better situated than were our ancestors. We know that thunderstorms do not sour milk, as was originally thought, but that it sours and deteriorates in other ways on account of the action of bacteria.

Bacteria are in reality tiny plants which can not be seen with the naked eye. Like most plants they grow best in a warm temperature and are checked in their growth by cold. It is not necessary, however, to freeze them to prevent them from multiplying rapidly. Most bacteria reproduce very slowly when kept under 50° F., even though they are in milk, which is almost an ideal food for them.

Why Milk Sours During a Thunderstorm

The intense heat which usually precedes a thunderstorm causes the rapid growth of bacteria which may have found their way into milk. Under such conditions, the souring of milk is due to the rapid multiplying of bacteria rather than to the thunder. Milk which has been thoroughly cooled soon after being drawn from the cow's udder and placed in a can kept standing up to its neck in ice water will be kept cold and will not sour any more quickly because it thunders.

It stands to reason, then, if we are to produce milk of high quality, have it keep its good flavor, and keep it sweet for at least 24 hours after it reaches the consumer, we must pay special attention to its temperature. The bacteria which do the most damage to milk simply do not thrive when it is kept cold.

So, Mr. Dairyman, if you have been in the habit of hurrying away with your morning's milk before it is thoroughly cooled, do not be surprised if the dealer who buys it is dissatisfied. If you have held your evening's milk over night without cooling it sufficiently, don't be shocked if it is returned to you marked "sour" or if you receive word from the health department that your milk contains too many bacteria to be acceptable. You may have observed all the rules of cleanliness in producing the milk, but you couldn't prevent a few bacteria from getting into it. And if you haven't checked these few bacteria by cooling your milk and keeping it cold, they may have multiplied into uncountable numbers.

A Cold Spring is a Fortunate Possession

The dairyman who has a cold spring handy to his barn or whose well contains cold water the year round is fortunate indeed. A plentiful supply of pure, cold, running water is a boon to any milk producer. Given an available supply of cold water, most milk producers are ingenious enough to make the most of it, especially when it means money in their pockets.

Almost any dairyman can build a cooling tank large enough to hold his milk cans. He can place this tank where water from his spring or pump will run through it. Then he can see that as soon as his milk is drawn from the cows it is strained into cans which are placed in the running water up to their necks. It isn't much trouble to stir the milk a little each time he comes from the barn with more milk, and thus cool it more quickly.

If he is wise, he will not rely on one tank of water to cool a number of cans of milk. This would result in just the opposite to what is desired. Very likely the warm milk in the cans would heat the water in the tank to such an extent that it in turn would keep the milk at a desirable temperature for the growth of bacteria for hours even if the surrounding air were cool.

Run the Milk Through a Cooler

If running water is not available, the wise dairyman will use enough ice to bring his milk down to 50° F. or below if he wishes to prevent the bacteria from multiplying rapidly. That is, he will if he uses a cooling tank. He may prefer to use a surface cooler, over which the milk is allowed to flow slowly while it is kept cold on the inside by running water, or ice water.

A dairyman who wishes to cool his milk quickly, perhaps so he can bottle it for early delivery to the consumer, may use a surface cooler to advantage. If he desires information on cooling milk, he may write to his State agricultural college or to the United States Department of Agriculture for bulletins on cooling milk and cream on the farm. But there is one thing certain: If he is selling milk which must be hauled some distance or shipped by rail before it reaches the consumer or the dealer, he will have to cool his milk thoroughly in some manner if it is to be of good quality.

And speaking of hauling the milk, another question is raised which deserves the attention of the dairyman who desires to control his bacteria counts. Many

have been the instances where untiring efforts were made to prevent contamination of the milk while it was being produced, where it was quickly and thoroughly cooled and then allowed to stand in the sun by the side of the road for an hour or two waiting for the milk truck to pick it up.

Keep Cans of Milk Cold

In many cases the farmer has other work which must be attended to and which will not allow him to meet the milk truck at a certain time. If this is so, he can at least provide shade for the milk cans and, better still, a canvas or similar covering in addition, to prevent the milk from warming so fast. If the farmer hauls the milk himself, he should keep it carefully covered and he should insist that anyone else who hauls it does the same.

In cases of long hauls it may pay to provide insulated jackets for the cans. In any event, every precaution should be taken to keep the milk cold in transit. In these days we hear of milk being transported for long distances and remaining in good condition. This would not be possible, however, were it not that it is cooled thoroughly before starting on its journey and that it is kept cold until it reaches its destination. Bacteria do not thrive in cold milk.

Lecture 5. Effect of Feeds on the Flavor and Odor of Milk

C. J. BABCOCK

Cows' milk invariably has a characteristic flavor and odor, more or less pronounced, but comparatively little is known concerning the factors contributing to these characteristics. The flavors vary from those which are pleasing to others which make the milk objectionable.

Flavors and odors in milk result mainly from four causes: (1) The physical condition of the individual cow, (2) highly flavored feeds, (3) odors absorbed by

the milk after production, and (4) changes in the milk due to bacteria.

Flavors and odors caused by the physical condition of the cow and by highly flavored feeds are noticeable just after the milk is drawn and usually do not increase with time. Those caused by absorption after the milk is drawn develop only when the air to which the milk is exposed is filled with pronounced odors, whereas those caused by bacteria become more apparent after milk has been left standing.

Milk of pleasing quality can be produced only when the factors affecting the flavor and odor of milk are controlled. This department has conducted investigations considering principally the factors that cause feed flavors and odors in the milk.

Some Feeds Have Pronounced Effect

These investigations have shown that when corn silage, legume silage, green alfalfa, cabbage, and turnips are fed to dairy cows one hour before milking the flavor and odor of the milk are seriously affected. Green rye, green cowpeas, potatoes, dried beet pulp, and carrots affect the milk only to a slight degree; whereas green corn, green oats and peas, pumpkins, and sugar beets have practically no effect on the flavor and odor of the milk produced.

Although feed-tainted barn air may have some effect on the flavor and odor of milk, it is of relatively small importance even under extreme conditions, for feed flavors and odors are imparted to milk mainly through the body of the cow and not by absorption from the surrounding air.

Highly flavored feeds may be fed immediately after milking without seriously affecting the flavor and odor of the milk produced at the next milking.

Most feed flavors and odors are more pronounced in cream than in the milk from which the cream is skimmed.

Proper aeration reduces strong feed flavors and odors in milk, and slight feed flavors and odors may be gotten rid of.

Garlic Gives Quick Results

In order to obtain further and more definite information concerning the time required for feed flavors and odors to enter the milk and the time required after consumption before the flavor and odor will have disappeared, as well as the methods by which the flavor and odor may enter the milk, experimental work was carried on with garlic, and the following conclusions were reached:

Garlic flavors and odors may be detected in the milk when the samples are taken one minute after feeding one-half pound.

The strength of the garlic flavor and odor increased as the length of time between feeding the garlic and taking the milk samples increased until at 10 minutes a high degree of garlic flavor and odor was reached. This remained to an objectionable degree for 4 hours, after which there was a decrease; and at 7 hours it had practically disappeared.

Strong garlic flavor and odor were found in milk drawn two minutes after the cows inhaled garlic odor for 10 minutes. This took place in such a manner that it was impossible for the cows to eat any of the garlic. The cows were then milked in an atmosphere free from garlic odor. The garlic flavor and odor imparted to the milk in this manner practically disappeared in 90 minutes.

Garlic odor was readily noticed in samples of blood drawn 30 minutes after feeding the cows 2 pounds of garlic tops, and strong garlic odor was present in the blood drawn 45 minutes after such feeding.

These data indicate that the feed flavor and odor are absorbed by the blood from the stomach; or, in cases where the feed has a pronounced odor, to some extent from the lungs and thence passed on to the milk.

Many Feeds Impart Objectionable Flavors

Milk is often made unsalable by feed flavors, while that which is pleasing to the taste extends the market by increasing the quantity consumed. Many feeds impart objectionable flavors to the milk. Therefore

proper methods of feeding are necessary in the production of milk of pleasing taste.

These experiments show that feed flavors may be avoided by controlling the time of feeding, for in most cases feed flavors are not imparted to milk except for a few hours after feeding. For this reason dairy cows should be fed highly flavored feeds immediately after and not just before milking.

Pastures should be cleared of weeds which cause objectionable flavors and odors in milk. Until this is done, cows should be removed from infested pastures as long as possible before milking. The longer the time between removing the cows and milking the less noticeable are the undesirable flavors. Some weeds, however, have a tendency to impart objectionable flavors several hours after consumption; when such weeds are present it may be necessary to give up pasturing until the weeds are destroyed.

In the production of milk of pleasing taste preventive measures are always best. Therefore, in addition to feeding, just after milking, all materials likely to taint milk, dairymen should try, first, to have cows and barns clean; second, to have cow stables properly ventilated; and, third, to decrease the feed and barn taints by proper and immediate aeration. Finally, prompt cooling and storing of milk at a low temperature will check the development of flavors and odors from the action of bacteria.

Lesson 6. Cleaning Milking Machines

L. H. BURGWALD

The use of mechanical milkers is becoming more common in the production of market milk, and this brings up the problem of cleanliness. If the milking machines are not washed and sterilized properly, they may be the direct cause of large numbers of bacteria in milk.

The ability of well-informed and careful dairymen to produce clean milk having a low bacteria count with milking machines has been demonstrated by the fact that certified milk is being produced with

them. This is a very high-grade milk produced under the direction of a medical milk commission and must not contain more than 10,000 bacteria per cubic centimeter at the time of delivery to the consumer.

Market milk of a good grade is also being produced with machines operated under ordinary farm conditions. There is no short cut to cleanliness, however, and clean milk can not be produced by using neglected machines.

Follow Definite Instructions Carefully

It is important that definite cleaning instructions be followed by each milking-machine user. There are numerous parts to a milking machine which need careful attention. Chief among those are the rubber tubing, teat cups and inflations, claw, pail, head, valves, and moisture trap.

This department has conducted investigations on several methods for cleaning and sterilizing milking machines, and from the results obtained it advocates the "heat method," or a variation of it, as being both simple and effective in producing milk uniformly low in bacteria.

The Heat Method of Cleaning

The method is as follows:

Immediately after milking the machines are rinsed with cold or lukewarm water drawn through the machines by vacuum. The flow may be broken occasionally by pulling the teat cups out of the water and then immediately immersing them again. This is done 10 or 12 times. This process is repeated, using hot water containing washing powder, and the teat cups and tubing are washed with a brush. Then the machines are rinsed by drawing clean hot water through them by vacuum.

The long milk tube with claw and teat cups is then removed from the head of the pail. The air tubes (on machines of inflation type) are plugged, and the whole is placed in a tank or can of clean water, care being taken that all parts are entirely covered. The water is then heated, preferably with steam, to a

temperature of 160° to 165°F. and then allowed to cool gradually, the parts to remain there until the next milking. A covered tank or can is preferable.

Where steam is not available for heating, the water may be heated in a wash boiler on a stove. If this is done, it is best not to place the rubber parts in the water until the proper temperature has been reached and the boiler removed from the stove; otherwise the rubber parts may be injured by coming into too close contact with the heating medium.

Take Machines Apart Frequently

It is desirable that twice each week the machines be taken entirely apart and washed thoroughly with brushes and hot water containing washing powder.

The moisture trap or check valve on the head of the machine requires cleaning every day.

Milking-machine pails and covers require thorough washing after every milking and then sterilizing, preferably with steam. It is necessary that pulsators and electric motors, when on the head of the pail, be removed before sterilizing. If steam is not available, the covers and pails may be sterilized by immersing in boiling water for five minutes.

The vacuum line ought to be cleaned at least twice a year by drawing hot water containing washing powder through it with vacuum. If milk is drawn into the vacuum line, it is necessary that it be cleaned immediately after milking.

Bacteria counts obtained on comparative tests made with machines sterilized by this method with those sterilized in a chlorinated-lime solution showed the superiority of the heat method for sterilizing.

Life of the Rubber Parts

In tests carried on by the Department of Agriculture on the length of life of the rubber parts when using the heat method for sterilizing, the average length of life of the teat-cup liners was about 13 weeks. The short rubber milk tubes lasted about 24 weeks, while the short air tubes and long milk tube lasted for nearly 31 weeks.

Observations made at different farms have shown that some users have obtained as long as 17 weeks' wear out of the teat-cup liners when this method for sterilizing was employed, whereas others have obtained only 6 weeks' service. This variation may be attributed to four causes: (1) The grade of rubber used in making the liners, (2) the number of cows milked with a set of rubbers, (3) the condition of the rubbers when discarded, and (4) the care and cleanliness of the rubbers.

Often the life of the rubber parts varies considerably under exactly the same care and use. This is undoubtedly due to the difference in the grade of rubber.

The number of cows milked with the machine and the number of milkings each day also affect the life of the rubber parts. The oftener they are used the sooner they wear out.

It was noted that there is a great difference in the degree of wear at which the rubbers are discarded by various operators. Some operators replace rubber parts that are still in good enough condition to last several weeks. These operators are usually those who have large numbers of cows to milk. They say that the time saved in milking by replacing rubbers frequently more than pays for the additional expense of new rubbers. In no case, however, should old, cracked, or split rubbers be used.

It is necessary that the rubbers be thoroughly cleansed before sterilizing, as butterfat has a harmful effect on them at the temperatures used for sterilizing and shortens their life materially.

Place Rubber Parts in a Refrigerator

In further tests conducted by the department it was found that removing the units from the hot water at the end of 20 to 40 minutes and placing them in a refrigerator would lengthen the life of the rubber parts materially. In checking the growth of bacteria, equally as good results could be obtained as when the units remained in the hot water between milkings.

If no refrigerator is available, the unit, after sterilizing in hot water at 160° to 165° F. for 20 to 40 minutes, may be hung in the milk room or placed in a weak chlorinated-lime solution. This solution is made by dissolving a 12-ounce can of chlorinated lime (containing 24 per cent available chlorine) in 1 gallon of water and then filtering. One ounce of this solution is then added to 3 gallons of cold water, and is made up fresh daily.

Detailed results of these investigations can be found in Farmers' Bulletin 1315, *Cleaning Milking Machines*, which may be obtained by writing to the United States Department of Agriculture.

Lesson 7. The Cream Separator

WILLIAM WHITE

To get the best results in gravity separation cool the milk at once to as low a temperature above freezing as possible. Then set it away in a clean, cool place free from odors. Deep setting in cold water is better than the shallow pan; that is, you get a more complete separation with less loss of butterfat in the skim milk. You also get a better quality of cream.

The water-dilution method was very popular at one time, but it is not now generally used. This method is not so effective as either the shallow pan or deep setting. Furthermore, it dilutes the skim milk, making it less valuable for feeding, and there is also danger of contaminating the cream by using impure water.

In gravity separation 12 hours is usually a sufficient time to allow the milk to stand before the cream is removed. In any case do not allow the milk to sour before skimming. Skimming may be done with a special skimmer or a dipper. Deep-setting cans are sometimes provided with faucets at the bottom through which the skim milk may be removed. This is a better way than removing the cream from the top.

Centrifugal Separator Gives Best Results

Skimming with the centrifugal cream separator is, of course, the best method of all, because fresher cream can be had; less cream or fat is lost in the skim milk. Besides, the skim milk is fresher and better for calves.

The machine should be placed in a clean, well-lighted dairy house where there are no odors to contaminate the milk and cream during separation. In order that it may be firm when in operation, it must be set perfectly level and tightly fastened on a solid foundation, preferably of concrete. If that is not done, the running of the machine will cause the frame to vibrate, and, as a result, the bowl will not run true, the bearings will wear quickly, and the separation of cream from the milk will not be nearly so complete; that is, butterfat will be lost in the skim milk.

A cream separator is one of the most delicate machines in general use on the farm and should be handled with the care its construction demands. It should be run according to the directions furnished with the machine. Bearings and gearings should be kept clean, free from grit, and well lubricated with good oil. If a speed indicator is not used, the revolutions of the crank should be timed by a clock or a watch. In turning, even pressure should be kept on the handle throughout the revolution, as jerking causes unequal wear on the bearings and the gears.

Keep the Speed Right

A cream separator does its work most effectively only when run under proper conditions. It will not skim clean when it is run too slowly, as the centrifugal force developed is insufficient to separate all the cream from the skim milk. The vibration or wobbling of the bowl keeps the milk so stirred up that the normal separation of the cream can not be accomplished. When the bowl parts are bent, dirty, or not properly assembled, the machine can not function properly.

The lowest temperature of the milk for most effective separating is 90° F. When milk is at a lower temperature it is more viscous, and therefore the movement of fat globules through the skim milk and the flow of cream through the cream outlet is checked, resulting in a loss of fat in the skim milk and a somewhat smaller quantity of cream containing a higher percentage of butterfat. During the winter, if the separator is in a very cold room, the bowl should be warmed by running warm water through it so that the first milk that enters will not be chilled.

When through separating, a small quantity of skim milk should be run through to flush the last of the cream from the bowl.

Cream Screw Regulates Richness

The richness of the cream can be regulated, to a large extent, by the adjustment of the cream screw. Certain variations in the fat test of the cream, however, are bound to occur even though the separator be run with the utmost care. Decreasing the speed of the machine produces a larger quantity of cream containing a smaller percentage of butterfat.

Cream having a higher test than normal may be the result of the milk being cooler than usual or of the separator running below capacity or running dry occasionally. Other things being equal, the richer the milk run through the machine the richer the cream will be. This may be the cause of a seasonal variation in the test of a dairyman's cream when the average test of the herd milk is higher at one season of the year than at another. The amount of dilution caused by flushing the last of the cream from the bowl with skim milk is an especially large factor affecting the test of the cream when the quantity of milk separated is small.

Like all other milk utensils the cream separator should be cleaned thoroughly immediately after use. Merely flushing the bowl with water after one skimming and taking it apart for washing only every second time it is used is a practice that must be

condemned. The thorough cleaning of the separator every time it is used is necessary to the production of high-quality cream.

Clean Each Time After Using

Unclean separator parts harbor bacteria that contaminate the cream and injure its market value when the machine is used again. An unclean separator may cause financial loss through lowering the quality of the cream and also by causing the machine to skim less efficiently. In order to avoid these financial losses good business management of the dairy demands that the separator be cleaned thoroughly each time it is used.

All parts of the bowl, together with the tinware that comes in contact with the milk, should first be rinsed with lukewarm water, then thoroughly scrubbed with a brush in warm water in which soda ash or similar washing powder has been dissolved. Soap or soap powder is liable to leave a soapy film on the surface of tinware and should not be used.

After having been scrubbed, the parts should be thoroughly rinsed in clean warm water, then sterilized in a steam sterilizer if one is available, or placed in water and boiled for at least five minutes. The use of a dish towel or cloth for drying is not desirable or necessary, because the hot utensils will dry of themselves; and in order that they may remain sterile they should be handled or touched as little as possible.

Lesson 8. Caring for Milk in the Home

R. J. POSSON

Most of us have had experience, satisfactory and otherwise, in caring for milk to be used in the home. There is great satisfaction in serving milk or cream of high quality. On the other hand, it is very disappointing to find that these products have spoiled when one is ready to use them.

We still remember very clearly the time when we had our mouths "all set" for peaches and cream and

had the peaches all ready to serve and then found that the cream had soured. We also remember the time when mother expected to serve ice cream to company from town but couldn't because the cream from the previous evening had turned sour and only a little morning milk had been kept.

Some of the neighbors said the cream soured because we had had a thunderstorm, but we now know that the extreme heat before the thunderstorm was the underlying cause. We had been in the habit of keeping the cream overnight without any trouble. We didn't take time to cool it thoroughly before putting it in the cellar, and the temperature there was higher than usual. It was simply a case in which conditions were right for the multiplication of bacteria, and they increased in such numbers that the cream soured.

A Very Perishable Food

So, sooner or later, we all learn that milk is one of the most perishable foods and when neglected will not keep sweet. Just what is meant by neglect and proper treatment of milk in the home we hope to make clear in this short discussion.

Of course, the milk which we are to care for should be from a clean, healthy cow and should be drawn into a sterilized container by a clean, healthy milker who has not forgotten to wash his hands just before starting to milk. If we are to be successful in keeping the milk it must be of good quality to start with or our efforts will be wasted.

If we are so fortunate as to live near the milk house from which we ship or bottle market milk, we probably can keep our milk or cream there until we are ready to use it. The milk house likely has cold running water, ice water, or a refrigerator, and it costs little or nothing extra to keep the milk and cream for the family there.

If we have conditions such as these, we are fortunate, indeed. But if we are like most people who must rely on provisions in the home itself for caring for these products, we must make the most of what we have to prevent bacteria from souring the milk.

Special Utensils are Needed

In the first place we should have special utensils for the milk and cream; that is, utensils which are used for no other purpose. These utensils should have smooth surfaces free from seams or cracks and should be of material which may be subjected to heat in preparing them for the milk. They should also be of a type which is easily covered. After being used, they should be rinsed in cold or lukewarm water and then thoroughly scrubbed with a brush in hot water containing some good washing powder (not soap powder). Rags should never be used in washing milk utensils, as they tend to smear grease instead of loosening it.

After the containers are washed they should be scalded with boiling water or actually boiled in water and then placed upside down in a protected place until they are used. If we will care for our milk containers in this manner, the battle of keeping the milk is half won. We are too apt to pick up the first utensil which comes handy. If it hasn't been scalded, it probably has on its surface many millions of bacteria which will cause the milk to sour.

If the milk or cream is cooled before putting it in the containers in which it is to be kept in the home, it will be easier to handle. If, however, the milk is put in the containers just as it comes from the cow, or the cream as it comes from the separator, the first task is to cool it thoroughly. Setting it in a cold place is not sufficient unless that place is cold water, preferably running water, or ice water.

Keep Cold at all Times

After the milk or cream is cooled it should be kept in the coldest possible place above freezing until it is used. A refrigerator will fill the bill to perfection, but those of us who do not have ice must resort to other means. Running water from a spring or well makes the best substitute for ice. Sometimes a barrel or small tank may be placed between the source of supply and the stock or storage tank and will serve as a first-rate storage place to keep perish-

able food. Another way is to place milk or cream in a tight pail or can and hang it in a cistern or well.

If these facilities are not available, perhaps there is a cool cave or cellar in which the milk or cream may be kept after it has been quickly and thoroughly cooled. These products should not be left in the pantry even in winter if it opens from a heated room, for bacteria multiply readily at ordinary room temperatures.

After enough milk or cream for immediate use has been taken from the container it should be returned to its regular storage place. Milk or cream removed from the utensil should not be returned to it, but should be kept separate to avoid contaminating the rest.

Use of a Cold Cupboard

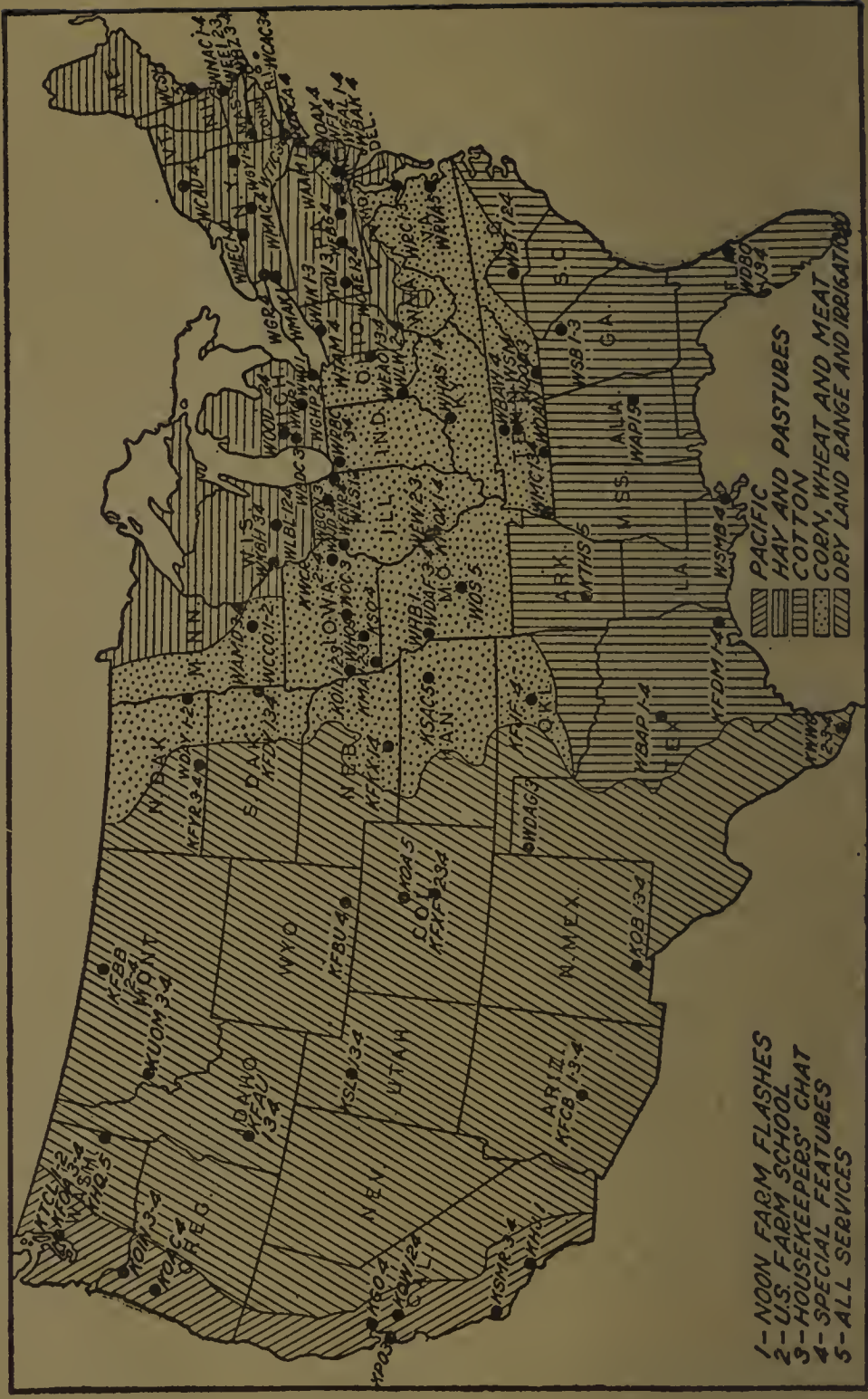
A handy means of storing milk and cream for family use in moderate weather may be provided by building a cold cupboard on the back porch or outside the kitchen window. A tight rain-proof box fitted with a tight door will be found very convenient, especially to those who use ice in the summer time and need a substitute in the colder weather.

Another thing to remember is that wherever milk or cream is stored it should be kept covered to protect it from dust and insects, especially flies. Flies breed in filth and are covered with bacteria. They are apt to carry disease organisms and therefore are absolutely dangerous to health. None of us want to use milk or cream which has been contaminated by flies.

It is not difficult to care for milk properly in the home if a few simple rules are observed. These are: First, avoid contamination by using utensils which have been boiled or scalded and by keeping the milk or cream covered and not returning any to the original container after it has once been removed. Second, cool the milk or cream quickly, and keep it in the coldest available place above freezing until it is used.



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Cap. 2

U.S. RADIO FARM SCHOOL

U.S. DEPARTMENT OF
AGRICULTURE

OFFICE OF INFORMATION—RADIO SERVICE

Dairy Short Course No. 3

FEEDING DAIRY CATTLE

December 3, 1926, to
January 21, 1927

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FEEDING DAIRY CATTLE

DECEMBER 3, 1926, TO
JANUARY 21, 1927

*By J. R. DAWSON, Bureau of
Dairy Industry*



This is the third group of printed lessons supplementing the U. S. Radio Farm School talks from broadcasting stations listed on inside of cover. All regularly enrolled students in the livestock, poultry, and dairy sections will be furnished the full series of booklets. These publications are mailed at the completion of each short course



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FEEDING DAIRY CATTLE

Lesson No. 1. Introduction and General Consideration

It is estimated that the 22,000,000 milk cows in the United States consume each year feed worth approximately \$1,100,000,000. This represents the cost to the farmers of the various kinds of hay, pasture, silage, root crops, and concentrates, such as corn, oats, barley, bran, cottonseed meal, linseed-oil meal, and other feeds.

These 22,000,000 cows are the dairy farmers' market for this amount of feed. A relatively small number of these cows return from \$2 to \$3 for each dollar's worth of feed eaten. It is easily seen that they are good feed markets.

On the other hand, a much larger number of cows return only \$1 or less for each dollar's worth of feed eaten. These cows are poor feed markets. Some of them are scrubs that have not been bred for high production. They will be low producers and poor feed markets as long as they are in the herds, regardless of the quantity and kind of feed given them.

Others are low producers, not because they are poorly bred and incapable but because they are not fed enough and are not given the right kind of feed. These cows would return a high market price for feed if they were given plenty of the right kinds.

A farmer who raises hogs, beef cattle, wheat, or potatoes spends a lot of time in figuring on what market will pay the highest price for his product. If Jones offers him one cent more per pound for his hogs or a few cents more per bushel for his wheat, he sells to him.

Eliminate Poor Producers

The dairy farmer ought to do more figuring on which of his cows return the highest price for their feed. If Blacky returns \$3 for each dollar's worth of feed eaten, he should feed her better and try to build up an entire herd like her. If Susie has had just as good a chance as Blacky and gives only \$1 in return for a dollar's worth of feed, he should sell her and all of her kind.

Essentials for Profitable Feeding

Therefore the first two essentials for profitable feeding are:

1. That your cows be capable—that is, that they have inherited the ability for turning a large amount of feed into a large amount of milk.

2. That they be given plenty of feed, such as good hay, silage, pasture, and grain.

In this connection Dr. C. H. Eckles, a noted authority on feeding dairy cows, states: "The inherited ability of the cow to produce milk and the skill with which she is fed and managed contribute about equally to the final results."

The average production of all the dairy cows in the United States is about 175 pounds of butterfat per year. This production could easily be raised 40 to 50 per cent by good feeding and management methods. A concrete example of this is the recent work of the Indiana Agricultural Experiment Station at Purdue University.

Results of Proper Feeding

This station purchased five promising but improperly fed cows from Indiana farmers. These cows were taken to the experiment station and given good feed and care.

Brownie produced 66 per cent more milk and 71 per cent more butterfat and Mary gave 57 per cent more milk and 47 per cent more butterfat under better feeding and management. All of the five produced more,

the average increase being 71 per cent in milk production and 56 per cent in butterfat production. Certainly they ate more feed—in fact, the figures show that they ate 65 per cent more—but at the same time the increase in return above feed cost was 74 per cent.

For the money invested in the increased feed of these cows a return of 101 per cent was realized. These cows proved to be good feed markets when well fed.

The Minnesota Agricultural Experiment Station got similar results in a like experiment. An added cost of feed of \$11.96 per cow resulted in an average increase of 77 pounds of butterfat for the year, while the income above feed cost was increased by \$25 per cow. The same general results were obtained with herds at the New York and Maryland Agricultural Experiment Stations several years ago. These cows were also profitable feed markets when skillfully handled.

What is true in the above States is also true in every State and in every county. There are thousands of poorly fed, half-starved cows on the farms of the United States that are more than willing to produce a large amount of milk and butterfat. Give these cows a chance. Then if they do not produce economically sell them to the butcher.

Lesson No. 2. Roughages for Dairy Cows

Roughages include the coarser types of feed. They have a much higher fiber content and supply a smaller amount of digestible material, according to their weight, than do the grains.

All the hays and grasses when cured or green, corn fodder, stover, straws, and silages are examples of roughage. Some of the milling by-products of the lower grades, such as oat hulls and cottonseed hulls, should also be recognized as roughages.

Root crops, such as beets, mangels, and turnips, though commonly looked upon as succulent roughages, are really watery concentrates because of their low fiber content.

Concentrates are those feeds that supply a large amount of digestible material in proportion to their weight. The fiber content is low. Practically all the grains and grain by-products, such as corn, oats, wheat bran, cottonseed meal, and linseed-oil meal, are examples.

Both roughages and concentrates are necessary for cows to do well. Dairy cows can live only a short time without roughage. Their stomachs are large and roomy, and they must have bulky feed to distend the paunch in order that the digestive organs will function properly.

Practically all roughage eaten by cows is first rolled up into a ball, swallowed, and is temporarily stored in one of the stomachs. Later it comes back into the mouth and is chewed thoroughly, after which it passes into the digestive tract.

Dry roughage may be divided into two groups known as the legumes and the nonlegumes.

The Legumes

The legumes, of which alfalfa, all the clovers, vetch, lespedeza, cowpeas, and soy beans are examples, are the best kinds of hay for dairy cows. They are high in protein and are rich in mineral matter, especially calcium. Their use will reduce the amount of high protein concentrates to be bought and make it easy to provide well-balanced rations.

Leafy, small-stemmed hay, cut before it is too ripe, and properly cured, is the best. In this condition it is more palatable and will contain a maximum amount of its natural green color. It is a hard problem to feed cows economically and get high production without the feeding of legume hays. It is usually cheaper to grow them on the farm than to buy them.

Alfalfa the Best Legume Hay

On account of its high protein and calcium content and its palatability, alfalfa is considered the best

legume hay for cows. Under most conditions it is also a high yielder.

Some farmers grind alfalfa hay and feed it as a concentrate like bran. Grinding will not make a concentrate out of it because of its high fiber content. Alfalfa hay will contain from three to five times as much fiber as wheat bran.

In some of the irrigated sections of the West, where the alfalfa is of high quality, dairy cows are profitably fed largely on alfalfa hay alone. This is further evidence of its high value as a feed.

Clover Hay Also Good

All the clovers make fine roughage for cows. Most dairymen consider that clover is not quite equal to alfalfa under most circumstances, but that it is a close second. The clovers, as a rule, yield somewhat less than alfalfa and furnish less digestible crude protein.

Other Legumes

Soy-bean and cowpea hay are well liked by cows, and they furnish about the same amount of protein as alfalfa. However, they are not quite so palatable because the stems are coarser.

Soy beans, cowpeas, and in some localities the vetches are easily and quickly grown and can often be grown in an emergency as a catch crop. If cut at the proper stage, they make good feed.

Sweet clover, another legume, makes fine pasture, but is not to be highly recommended as a hay crop because it is usually woody, stemmy, and unpalatable.

Nonlegume Dry Roughages

The nonlegume dry roughages, such as timothy, prairie hays, millet, sorghums, Sudan grass, stovers, and straw, are low in protein, less palatable, and are not recommended as good milk-producing feeds. If cut at the right time and cured properly, they may be used profitably as a portion of the dry roughage, but they are not so good as legumes.

If this kind of roughage is fed exclusively, more of the expensive high-protein concentrates as well as mineral mixtures will need to be purchased. At the same price per ton a pound of digestible protein will cost about three times as much in timothy as in alfalfa hay.

Mixed hay, such as clover and timothy, is about halfway between the legumes and nonlegumes in feeding value. It is a very important hay crop in the North Central States. The more legumes in this hay the better.

Succulent Roughages

Among the succulent roughages, pasture and silage are of most importance. Dairy cows always do better in early summer when the grass is plentiful and green. Because of the succulence that it provides, silage is the most economical winter substitute for pasture grass. Good cows will produce more and therefore cheaper milk if given silage or some other succulent feed during the winter.

Corn the Principal Silage Crop

Corn is the principal crop used for silage. Sorghums, both the saccharine and grain sorghums, are used to a large extent in the drier regions. The Kansas Agricultural Experiment Station has found them about equal to corn silage for milk production.

Sunflowers are sometimes used but not with general success. Legumes do not make good silage when used alone, but when combined with other crops, such as corn or oats, they make fair silage.

The use of good home-grown legume hay and silage is the basis of economical feeding of dairy cows. The cost of the grain portion of the ration will depend largely upon the quantity of these roughages available.

A dairyman who has several stacks or a barn full of legume hay and a silo full of silage need not worry about the winter feed bill. Every cow should have them.

Lesson No. 3. Concentrates

Concentrates differ from roughage in that they supply a larger amount of digestible nutrients according to their weight.

While it is desirable to feed plenty of good roughage, such as legume hay and silage, it is impossible for high-producing cows to get enough nutrients from roughage alone to supply their requirements. Therefore, it is necessary to feed a well balanced grain mixture along with the roughage.

All grains and nearly all grain by-products are concentrates. They are more expensive than roughages, and more care should be used to see that they are fed to the best advantage. With home-grown roughage available, a grain mixture should be used that will balance the roughage to meet the requirements of the cows. This is the practical application of balanced rations.

A Proper Ration

The constituents of the ration with which we are usually concerned are the proteins, carbohydrates, fats, and minerals. Among these the proteins and minerals perhaps need the greatest attention. Discoveries in recent years point out the great necessity of minerals for dairy cows.

It is important also to get the proper balance between the amount of protein and the carbohydrates and fat. The amount of protein to provide in the grain will depend largely on the amount present in the roughage.

Protein is used by the animal in making blood, muscle, and milk, and to carry on other body functions. A lack of protein will surely limit milk production. It does not pay to feed too little protein, and it is a waste to supply more than is needed.

Carbohydrates and fats supply energy and heat mainly. They also help to produce milk.

The principal requirements of a grain mixture outside of the nutrients it supplies should be (1) bulk, (2) palatability, and (3) variety. The ration should

have a desirable effect upon the animal body and products. Neither a constipating ration nor one too laxative is desirable.

Important Concentrates for Dairy Cows

The following statements give some of the most common concentrates for dairy cows and their importance in the ration:

Wheat bran.—Slightly laxative and well liked by cows. High in minerals, especially phosphorus, and moderately high in protein. It is bulky and is one of the best feeds for cows.

Wheat middlings.—Very much the same as bran but a little higher in protein and somewhat lacking in bulk.

Linseed-oil meal.—High in protein, laxative, very palatable, and has good effect on cows. Should be fed in connection with bulky feeds.

Cottonseed meal.—Probably highest in protein of any common concentrate. Should not be fed in too large quantities and should be used with bulky feeds, such as bran and oats.

Gluten feed.—High in protein, palatable, and often a cheap source of protein.

Hominy.—A high carbohydrate and low protein feed. A good substitute for corn.

Beet pulp (dried).—A poor source of protein. It is bulky and has fine effect on cows. When soaked in water it makes a good substitute for silage.

Molasses.—Very low in protein, high in carbohydrates and fat. Often diluted with water and sprinkled over poor quality hays. Laxative in effect.

Corn.—Palatable and usually the cheapest source of carbohydrates and fat. Should never be fed alone, because not properly balanced. Low in protein and heavy.

Oats (ground).—Higher in protein than corn, slightly laxative, and good feed for cows.

Barley (ground).—Much the same composition as corn. Makes good substitute for corn if cheap enough.

Rye (ground).—Not especially palatable, but is a good feed when properly mixed with others.

Grains should always be ground or crushed for dairy cows.

Good Grain Mixtures

The two following grain mixtures are simple, practical, easily mixed, and contain a large proportion of home-grown grain. They are well adapted for use with legume hay and silage and contain about 16 per cent digestible protein.

NO. 1

100 pounds corn meal.
100 pounds ground oats.
100 pounds cottonseed meal.
100 pounds wheat bran.

NO. 2

300 pounds corn meal.
100 pounds cottonseed meal.
100 pounds linseed-oil meal.
200 pounds ground oats or wheat bran.

For use with low protein roughages, such as timothy, prairie, and millet hays, or corn stover and silage, a grain mixture of 19 or 20 per cent digestible protein is recommended.

Two suggested grain mixtures are as follows:

NO. 1

100 pounds corn meal.
100 pounds cottonseed meal.
100 pounds linseed-oil meal.
200 pounds wheat bran.

NO. 2

200 pounds corn meal.
150 pounds cottonseed meal.
100 pounds gluten feed.
100 pounds wheat bran.

Be sure that you have a plentiful supply of legume hay and silage. Using these as a basis, work out a grain mixture that will balance these. Use as much home-grown grain as possible, but do not fail to supply enough protein, regardless of cost.

Write to your State agricultural college for a bulletin on feeding dairy cows. This will supply you with information on feeds and rations that will apply to your locality.

Lesson No. 4. Winter Feeding and Feeding Practices

The quantity of hay, silage, and grain to feed will depend largely upon the condition and production of the cows. All cows do not produce the same amount of milk and butterfat; consequently, they should not be given the same amount of feed. Economical feeding usually demands that cows be fed to full producing capacity.

Under most circumstances during the winter when cows are in milk and largely on dry feed they should be given all the roughage that they will eat readily, and the grain ration should be adjusted according to the individual cow's production.

Keep a Cow Just a Little Hungry

If a cow leaves part of her hay or silage or does not clean it up greedily, it is a pretty good sign that she is getting a little too much. It is always good practice to keep a cow just a little hungry.

A cow will eat from 7 to 20 pounds or more of hay, depending on her size and condition and on the kind and quality of the hay.

Suggestions for Feeding

Hay may be fed loose in the manger or in a feed rack. It is usually given after milking in order to prevent dust in the stable during milking. Since it is not practicable to weigh it every day, weigh a bunch occasionally in order to estimate pretty closely how much the cows are getting.

While grinding may insure a somewhat greater consumption and less waste for a poor quality of hay, ordinarily it does not pay to grind a good quality of hay. If baled hay is fed, be very careful that cows do not swallow pieces of baling wire. Many good cows have died as a result of this. Moldy or musty hay is not a desirable feed for cows.

The amount of silage cows will eat varies from 25 to 50 pounds. Small cows take less and large cows may take more. Weigh a forkful occasionally to check up on the quantity being fed. While silage is a cheap

feed, ordinarily it does not pay to force cows to take more than they want.

Feed the silage as soon as it is taken from the silo, and do not feed it when frozen, as this will cause scours. Feed it after milking to prevent the milk from taking up the flavor and odor. A low feed truck that can be pushed in front of the mangers will help greatly in feeding silage.

The grain mixture should be fed in the proportion of about 1 pound of grain to each 3 to 4 pints or pounds of milk produced daily. Cows giving milk testing 3 to 3½ per cent butterfat should be fed at the rate of 1 pound of grain to 4 pounds of milk. Those giving milk testing 5 per cent or more should get 1 pound of grain to each 3 pounds of milk. Some breeders follow the rule of feeding 1 pound of concentrates per day for each pound of butterfat per week. Each cow is an individual and differs in some respects from the others. A careful feeder will take this into consideration.

In order to feed cows according to production, it is absolutely necessary to weigh the milk, if not every day, at least often enough to know the approximate daily production.

One-half of the grain is ordinarily fed in the morning, the remainder at night. If cows are milked three times or more per day, the grain should be proportioned accordingly. It is common practice to feed it just before or during milking. Some breeders spread it over the silage. All grains should be ground or crushed. There is little value in cooking or soaking grains for dairy cows.

Grain mixtures may be made at home after the ingredients have been purchased separately, or they may be bought in the mixed form.

Importance of Pure Water

Water in many cases is cheap and plentiful and is not considered a feed. However, water makes up more than three-fourths of the total volume of the milk and therefore should be given careful consideration. Cows should not be made to drink impure water, as it may make the milk unsafe to use or be dangerous to the cow herself. During the winter, if

the cows are in the stable, they should be watered two or three times a day. Drinking cups in the stable are a good investment and will usually pay for themselves many times in increased production. It is good practice to warm the water for cows during the coldest weather, because it is probably cheaper to heat the water with wood or coal than for the cow to heat it in her body on expensive feed. This is especially true with higher producing cows. Heat the water to about 15° or 20° above freezing.

Be Generous with Salt

Dairy cows should have plenty of salt. The quantity will vary with the kind of feed and the size of the animal. Many dairymen mix salt with the grain, about 1 pound of salt to each 100 pounds of grain. This is good practice. An additional amount of salt should be provided so that the cows can take more if wanted.

Lesson No. 5. Minerals for Dairy Cows

During the last few years important discoveries have drawn the attention of dairymen to the necessity of supplying minerals to dairy cows. The following questions are of especial interest to dairymen:

1. What minerals are needed?
2. What will happen if cows do not get a sufficient quantity of these?
3. How can they best be supplied?

Minerals are undoubtedly necessary, but it is probable that the matter has been somewhat overemphasized as far as the average cow is concerned.

The necessary amount of minerals can not be supplied, however, by feeding supplementary mineral mixtures but by furnishing cows with roughage and concentrates that are known to be rich in minerals.

Importance of Calcium and Phosphorus

Calcium and phosphorus are of most importance. A lack of these in the feed may seriously lower the production of high producing cows and may also cause

breeding troubles. Since milk is very rich in both of these elements, dairy cows must get large amounts of them in their feed because they can not be made in the body. Calcium or lime is usually scarcer than phosphorus, which is found in large quantities in high protein concentrates, especially wheat bran, also cottonseed meal and linseed-oil meal. If from one-fourth to one-third by weight of the grain mixture includes either of the above-mentioned feeds, the cows will get plenty of phosphorus.

On the other hand, practically all of our common concentrates are low in calcium. This mineral is found in large quantities in well-cured legume hays of green color, especially alfalfa, clover, and soy bean. One pound of alfalfa hay contains as much calcium as 100 pounds of corn or 7 pounds of timothy.

Another point in favor of the legume hays with a high per cent of their natural green color is the presence of vitamin D, which experiments have shown is contained in these hays and which is essential in order that the cows may make full use of the calcium present. The best way, therefore, of furnishing a sufficient amount of calcium or lime to dairy cows is to grow and feed plenty of legume hays.

In many parts of the country it is harder to grow and cure legume hay than timothy hay. As a result, a great deal of timothy hay with a low calcium content is fed to dairy cows in these regions.

At the present time much attention is being given to the possibility of adding calcium in mineral form or as bone meal to rations consisting largely of timothy hay in order to make these rations satisfactory.

Direct Feeding of Mineral Calcium and Lime Doubtful

The advisability of supplying calcium in mineral form to cows on nonleguminous pasture is also being studied. Some investigators have obtained small favorable effects from the use of such minerals; others have obtained no favorable effects; still others have obtained harmful effects from the use of rock phosphate and from one of the commercial mineral mixtures which is at present on the market.

There is a very general agreement that even the best results that can be obtained by adding minerals to rations low in their natural calcium content are much inferior to those obtained by feeding well-cured legume hay without such minerals. Neither is there any satisfactory evidence that rations containing plenty of well-cured legume hay are improved by adding lime in mineral form.

In the case of nonleguminous pasture, it is probably better to use some form of lime on the pastures, thus making possible the growth of leguminous plants, than to feed it in mineral form to the cows.

Experiments indicate that it is even less advisable to buy the expensive commercially mixed mineral supplements which are at present on the market than to feed bone meal and ground limestone to dairy cows. The elements most needed are calcium and phosphorus, and these are supplied in smaller quantity by the mixtures than by bone meal and ground limestone. In the only case in which the effects of one of the mineral mixtures have been tried out experimentally, the results have been very unfavorable.

At the end of the winter the bodies of high producing cows are often very much depleted in calcium. They have given off in the milk a great deal more calcium than they have taken in from the feed. The difference has been taken from the bones. Leguminous pasture is a rich source of calcium and of the vitamin associated with it.

As the bones of cows are likely to be depleted during their lactation periods, it is advisable to give them reasonably long dry periods in which to recuperate. High-producing cows should be given dry periods of at least two months.

Supplying Iodine

In some sections of the country dairy cows are affected by a lack of iodine in the feed. This results in goiter or big neck in calves, usually at birth. If this trouble is experienced in a herd, iodine should be fed to the pregnant cows. The feeding of iodine should be begun as soon as there is reasonable cer-

tainty that the cow is pregnant and should be continued until she calves. Iodine is best fed in the form of potassium or sodium iodide, dissolved in water and sprinkled over the feed. Only a very small amount is needed. Get a 5 per cent solution of the iodide from your druggist and put one tablespoonful of the solution on the feed of each cow once a week.

Salt Is Important and Cheap

Salt is cheap and important from the mineral standpoint. Provide plenty of it.

Lesson No. 6. Planning Next Summer's Feed

When cows are off pasture and are being given dry feed, it is well to consider the problems connected with summer feeding. It is advisable to start planning now the system to follow next summer. If you do not have plenty of pasture, plans should be made to improve it and also to provide other succulent feeds to take its place, or to supplement it.

Many farmers think that pasture alone can be depended on for high production. This is a mistake. If it is plentiful, fresh, and green, it may furnish sufficient feed for maintenance and full production of milk. But not more than one pasture in ten will come up to this standard. Therefore, every dairyman should give consideration to its improvement, especially by the application of manure or top dressing with commercial fertilizer and by frequent mowing.

Write to your State agricultural college and find out the best grass mixture for pastures in your locality.

Supplement the Pasture

The condition and production of the cows and the kind of pasture should be considered. Ordinarily it is poor practice and uneconomical to try to save feed by depending entirely on pastures. Since they are usually overstocked and tend to get short and dry dur-

ing hot weather, it is well to supplement them with silage, soiling crops, and other feeds of this nature.

Under some conditions it will also pay to feed grain and hay to keep up the production of the higher producing cows in a herd.

The Summer Silo

A summer silo filled with good silage probably offers the cheapest substitute for short and dry pasture. A summer silo should have a small diameter so that a deeper layer of silage can be fed daily to prevent loss by spoiling. Silos 10 or 14 feet in diameter will be a good size for herds ranging from 20 to 40 cows.

If the summer silage is not needed or if any is left over, it may be fed the following winter or saved until the next summer. Many dairymen could well afford to build a smaller silo for this purpose.

Supplement the Pasture with Green Feed

Soiling crops are also grown, cut, and fed in the green state to supplement poor pasture. In general they are a little more expensive than silage on account of the labor of cutting and feeding.

A series of crops that will furnish green feed through the summer can be planned. Oats and peas, Sudan grass, green corn, soy beans, and alfalfa make good soiling crops.

Write to your State agricultural college or consult your county agent for recommendations about the crops to grow and the time to plant them. If they are planted at the proper intervals, green feed will be available all summer.

Whether or not it will pay to feed grain on pasture will depend upon the amount of milk a cow is giving. A cow giving a small quantity will ordinarily not pay for the grain, but a big producer will do so, and it is poor economy not to give grain to high-producing cows on pasture.

It must be borne in mind also that cows getting grain in the summer will give more milk the following winter when on dry feed.

The following figures will serve as a guide for grain feeding while your cows are on pasture next summer:

Guernseys or Jerseys producing—

20 pounds of milk daily require 3 pounds of grain per day.

25 pounds of milk daily require 4 pounds of grain per day.

30 pounds of milk daily require $5\frac{1}{2}$ pounds of grain per day.

40 pounds of milk daily require 8 pounds of grain per day.

Holsteins, Ayrshires, or Brown Swiss producing—

25 pounds of milk daily require 3 pounds of grain per day.

30 pounds of milk daily require 4 pounds of grain per day.

35 pounds of milk daily require $5\frac{1}{2}$ pounds of grain per day.

40 pounds of milk daily require 7 pounds of grain per day.

50 pounds of milk daily require 9 pounds of grain per day.

These recommendations apply only if the pasture is good. A good grain mixture can be made from ordinary farm grains, such as corn, oats, bran, and barley.

Caution

A final word of caution about pasture. Do not turn your cows on too early in the spring. The grass is watery, and if it is grazed too closely at this time it will be short all summer. When you think the pasture is ready, it is usually good practice to hold the cows off another week.

Lesson No. 7. Feeding Dairy Calves

Consideration of the problem of feeding the dairy calf should begin before the calf is born. Its dam should be healthy, well fed, and properly taken care of. If all calves were born under such conditions, there would be a higher proportion of good cows to poor ones.

It is estimated that one out of every three calves and heifers raised to maturity turns out to be unprofitable. Valuable milk should not be wasted on calves that do not have good breeding behind them. They should be selected from good sires and dams and then raised and fed properly.

Cleanliness Essential

Cleanliness is the first essential if calves are to be raised successfully. Feed, pens, pails, and bedding

should be scrupulously clean. Not only should the feed pails be washed thoroughly but they should also be sterilized with steam or scalded thoroughly with boiling water. Practically all calf diseases, such as scours, can be traced to lack of attention to cleanliness.

How to Raise Dairy Calves

Dairy calves should always be raised by hand. They should be allowed to suck the cow for a day or two after they are dropped, especially if they are weak. This also tends to make the cow better satisfied. The first milk of the cow is colostrum. It is thick and yellow and contains substances essential to the newborn calf.

When the calf is 48 hours old it should be taken from the cow and taught to drink, for the longer it sucks the cow the harder it will be to teach it to drink from a bucket. It is more difficult to teach some calves to drink milk from a pail than others. It is best to let them get very hungry.

Put warm, fresh milk from the dam in a clean pail and place it on the floor near the calf. Hold the pail so it will not tip over. Push the calf's nose into the milk. If hungry, many calves will often drink without further trouble after they get a taste. Others will have to be forced. This can best be accomplished by straddling the calf's neck and forcing its nose and mouth into the milk. If two fingers are placed in the calf's mouth it will suck the fingers; when the fingers are lowered into the milk the calf will drink more readily.

After a week or ten days, or as soon as the dam's milk is fit for human consumption, milk from the herd may be fed to the calf. It should be started, however, on its mother's milk. All milk not from tuberculosis-free cows should be pasteurized before feeding to calves.

The amount of milk that a calf needs will depend largely on its size and age. At birth a 50-pound calf should have about 8 pounds, or one gallon a day; while a larger calf, 80 to 90 pounds, should receive

about 12 pounds, or $1\frac{1}{2}$ gallons. It is better to give too little at the start than too much.

The milk for young calves should be fed at a uniform temperature all the time— 90° is about right. Young calves should be fed three times per day, and when they get a little older twice a day is often enough.

The majority of dairy calves are started on whole milk, and after the second or third week are gradually changed to skim milk. Grain is then fed to supplement the skim milk, since the fat has been removed from it. About two weeks should be taken up for this change. In the case of a weak calf, a longer period may be necessary. The feeding schedule given below is suggested as a guide. It may be necessary to change it to suit conditions.

Feeding Schedule

First and second weeks.—From 8 to 12 pounds of dam's milk for first four days. Later whole milk from the herd may be used.

Third week.—Begin to substitute skim milk for whole milk at the rate of 1 pound per day. Increase total quantity 2 to 4 pounds if calf is vigorous. Keep the calf hungry—do not overfeed it.

Fourth week.—At the beginning of the fourth week from one-half to three-fourths of the total milk should be skim milk. By the end of the fourth week the calf should be getting skim milk entirely.

Fifth week and thereafter.—After this time skim milk can be fed altogether if calf is vigorous. Increase the quantity gradually until 18 or 20 pounds a day is given.

Six months is a good age to wean calves. This will depend on their size and condition and season of the year. If skim milk is plentiful, it is a good idea to continue feeding it until the calves are 8 or 10 months of age.

Supplement the Skim-Milk Ration

When calves are raised on skim milk it is necessary to supplement this with other feeds. Suitable grain

mixtures for calves getting skim milk can be purchased or mixed at home. The following mixtures are recommended:

- (1) 3 parts cracked corn, 1 part wheat bran.
- (2) 3 parts cracked corn, 1 part wheat bran, and 1 part ground oats.
- (3) 3 parts cracked corn, 1 part wheat bran, 1 part ground oats, 1 part linseed-oil meal.
- (4) 5 parts cracked corn, 1 part wheat bran, 1 part ground oats, and 1 part blood meal.

Calves should receive grain during the second week and when a month old should eat about 1 pound a day. When 3 or 4 months old 3 pounds a day should suffice. Calves may be taught to eat grain by placing a handful in the pail after the milk is consumed. Never mix the milk and grain—feed them separately. Keep the feed boxes clean.

Milk Preferable to Calf Meals

If skim milk is not available or is too expensive, careful feeders can raise calves on calf meals or gruels. They will not be so vigorous as whole or skim milk fed calves, but if properly handled should develop to their normal size. The time at which calves can be put on milk substitutes will depend upon their development and vigor.

The following calf meal has been used with success at the experimental dairy farm of the United States Department of Agriculture, at Beltsville, Md.

Take 50 parts by weight of finely ground corn, 15 of linseed-oil meal, 15 of finely ground rolled oats, 10 of dried blood flour, 10 of skim-milk powder, and one-half part salt. Make a gruel by mixing with warm water at the rate of 1 pound of the meal to 9 pounds of water. Gradually replace the whole milk which the calf is getting with this gruel, feeding at the rate of about 2 pounds daily for a few days. When the calf is about 50 days old it should be getting only the gruel.

In feeding all calf meals or gruels the quantity fed should be substantially the same as when separated

or whole milk is fed. If, however, there are indications of indigestion, such as scours, the quantity should be reduced.

Calf meals lack a great deal of being as satisfactory as either whole or skim milk, and milk must be very high in price to justify their use during the first two weeks of the calf's life.

The same amount of grain and roughage should be fed with calf meals as with separated milk.

Feeding Roughage

During the second week vigorous calves will start to eat roughage. Clover or alfalfa hay of good quality should be given them, a small quantity at first so as not to cause scours. After calves are well started all the good hay that they will clean up should be given them. If good pasture is available during the first six months, no other roughage is necessary. However, it is best not to put very young calves on pasture.

Silage may be fed in small quantities after calves are a month old. The feeding of silage should be started gradually. Calves should be given as much pure fresh water and salt as they desire.

Lesson No. 8. Feeding the Dairy Heifer

The chief factor to be considered in raising heifers is that of feeding.

Heifers are unproductive; and for this reason there is a general tendency to skimp on their feed or to give them spoiled or left-over hay, silage, and grain. This is poor practice. Many cows are undersized and low producers because they did not get enough of the right kind of feed when they were young and growing. After a heifer has freshened and is producing milk it is difficult for her to make up the growth she failed to get as a younger animal because of poor feeding.

Heifers that have gained heavily during the winter because of liberal feeding will as a rule make smaller gains the following summer on pasture. Those which

are thin at the end of the winter will usually make comparatively heavier gains the following summer on good pasture.

The best method is to feed them in such a manner that they will grow gradually and normally at all times. This is evidenced by moderate flesh and a healthy, thrifty condition, which the experienced feeder can measure pretty accurately.

The Weaning of Calves

Calves should be weaned when about six months of age. If they are inclined to be small and undersized at that age, skim-milk feeding should be extended for another month or two, or even for a longer period if skim milk is plentiful.

It is important that calves get the proper attention at weaning time. The change from skim milk and grain to roughage and grain is radical unless it is made slowly and gradually. If this is not done, they will get a severe setback.

Calves dropped in the fall, weaned the next spring, and turned on pasture should do well the first summer. Heifers at this age have not developed any great capacity for rough feed, such as hay or pasture; and it is difficult for them to eat enough to obtain sufficient nourishment. They should have some grain in addition to pasture. They are growing rapidly and require plenty of growth-making feed, especially protein and lime, or calcium.

Spring-dropped heifer calves are harder to raise than fall calves. They are annoyed by heat and flies during the summer and are likely to be in poor condition in the fall. After they are weaned and put on dry feed they should be fed grain liberally all the first winter. After that they may be put on pasture and raised in the same manner as fall-dropped heifers.

Roughages

Investigations and practice indicate that heifers should be raised largely on roughage, provided it is of the right kind and quality.

Of the hays, the legumes are by far the best. If cut at the proper stage and well cured, they are well liked, are not coarse and stemmy, contain large amounts of growth-promoting and muscle-making proteins, and are rich in minerals, especially lime. Protein and lime are especially important for growing heifers.

The protein makes muscle and tissue, while the lime or calcium is used to build bone or framework. It is also desirable that a reserve supply of minerals be stored in the body because it will be needed when the heifer freshens and is producing milk.

Of the legume hays, alfalfa is the best, with the clover, soy bean, and cowpea next in importance in the order given. Experiments show that in order to obtain normal growth, heifers should have some grain in addition to legume hay.

Silage is a good roughage for growing heifers, but it is too bulky and too low in protein to be fed as the only roughage. A combination of a good quality of legume hay and silage makes the best roughage. In fact, heifers over a year old will often make satisfactory growth on it even if no grains are fed. They should be allowed to eat as much of it as they want.

Feeding trials indicate that when this is done, they will consume these feeds in the ratio of about two pounds of silage to one of alfalfa hay.

Pasture

Pasture grass is an excellent roughage for dairy heifers. If it is plentiful and of good quality, most heifers will need little or no additional feed during the summer. However, as many pastures are poor or are overstocked, it is well to supply silage and other roughage and some grain during a part of the summer, at least.

How to Feed Grain

The kind and amount of grain to feed heifers will depend upon their size and upon the kind and amount of roughage available. The following may serve as a guide for the feeding of grain during the winter:

1. When silage and legume hay are available, feed all the corn silage and legume hay heifers will eat. To heifers less than 10 months old, give about 2 pounds of grain daily in addition. The grain may be corn or a mixture of other grains, if more economical. For heifers within two or three months of calving, 3 to 5 pounds of grain will be necessary to put them in good condition for calving.

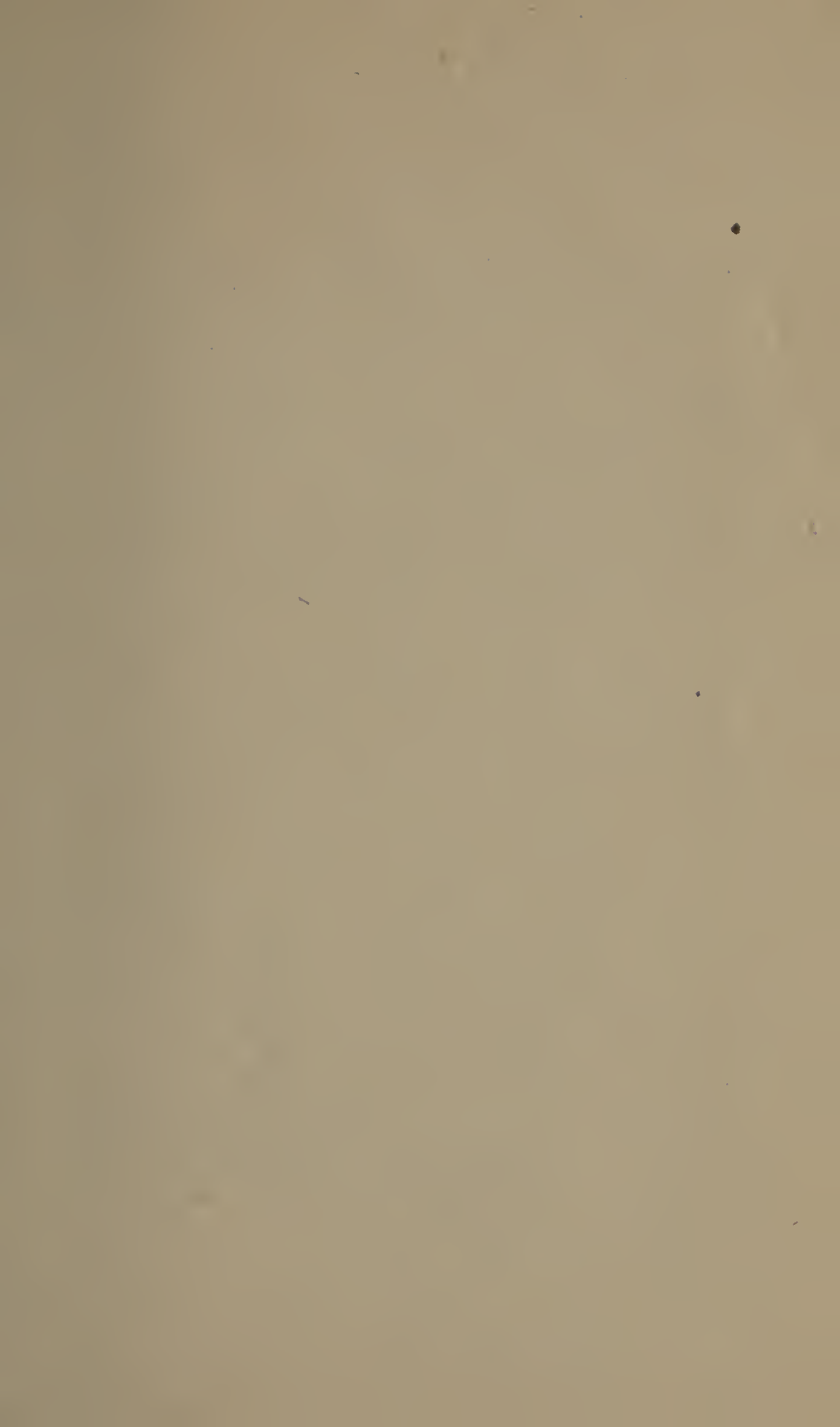
2. When silage, but no legume hay, is available, feed all the silage they will readily eat and some dry roughage, such as ordinary hay or fodder. About 3 pounds of grain should be given daily. One-half of this grain mixture should consist of feeds high in protein, such as linseed-oil meal, cottonseed meal, soy-bean oil meal, or gluten feed. The other half may be corn, oats, bran, or other feeds of like composition, depending upon price.

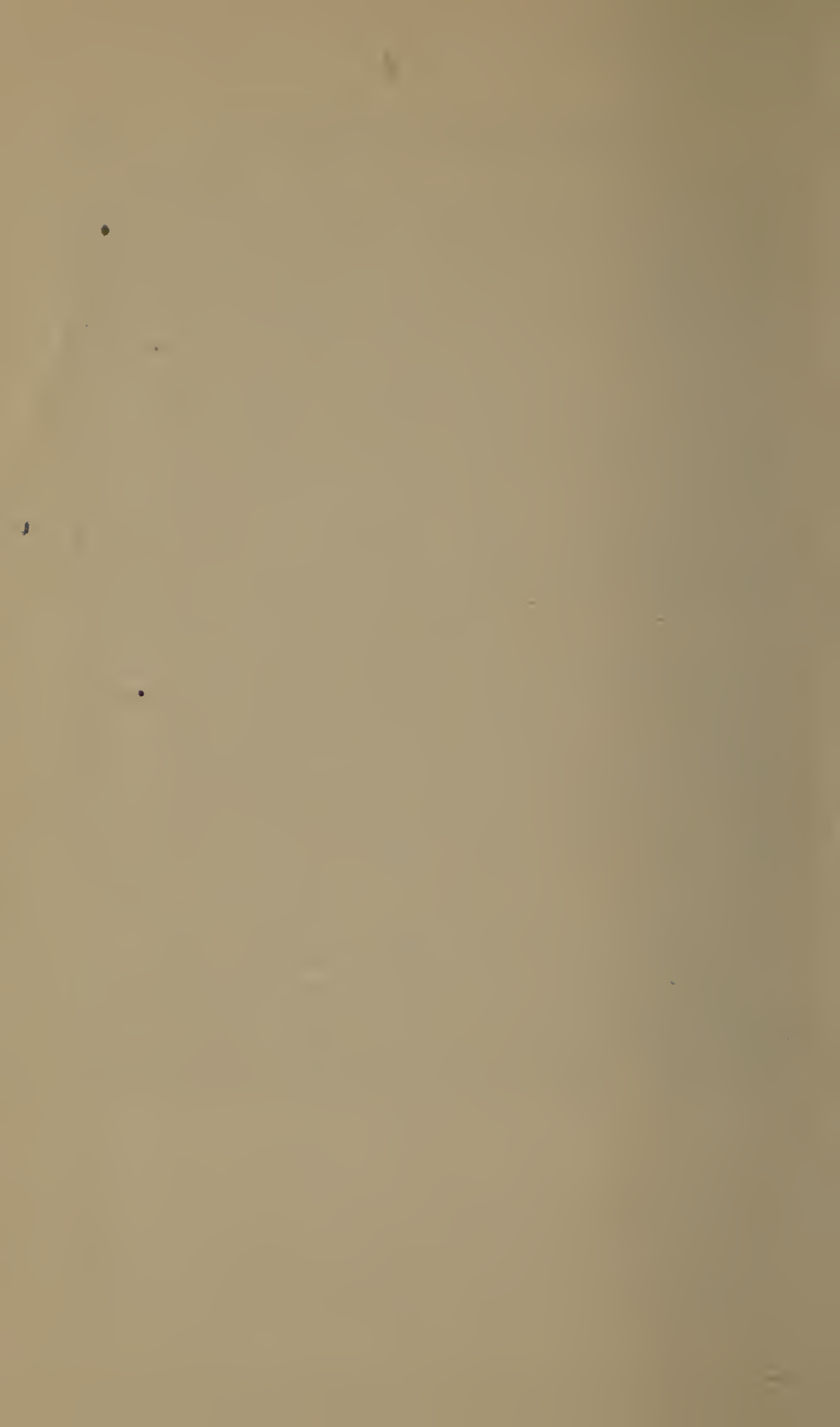
3. When plenty of legume hay, but no silage, is on hand, feed all the legume hay the heifers will eat and about 2 pounds of corn or similar grain daily.

4. When only nonlegume roughages and no silage are available, it is recommended that enough legume hay be purchased to make up one-half of the roughage fed. Feed a grain mixture composed of one-third by weight of high protein concentrates and two-thirds of corn or other similar grain. It is best to grind the grain.






These alternatives are really only makeshifts in the feeding program when legumes are not available. They are not satisfactory for continued feeding because they contain but little calcium, a mineral needed in fairly large amounts by the growing animal. For this reason dairy farmers everywhere should plan either to grow necessary legume hay or otherwise provide it in the ration for dairy heifers.







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Dairy Short Course No. 4

DAIRY HERD MANAGEMENT

December 3, 1926, to
January 21, 1927



By J. R. DAWSON, Bureau of Dairy Industry



Washington :: Government Printing Office :: 1927

Radio Stations Broadcasting the United States Farm School

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WGY-----	{ 6.20 p. m., Monday and Friday. 6.45 p. m., Wednesday.
WLS-----	6.15 p. m.
WCCO-----	7.30 p. m.
WOS-----	7 p. m.
KFKX-----	7.15 p. m.
WLW-----	1.40 p. m.
WHO-----	2.15 p. m.
KFXF-----	7.15 p. m.
KHQ-----	5.30 p. m.
KMA-----	11 a. m.
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KQW-----	6.35 p. m.
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KVOO-----	11.30 a. m.
KWCR-----	8.55 p. m.
WCAE-----	7.10 p. m.
WCSH-----	7.30 p. m.
WEW-----	5 p. m.
WGHP-----	6.40 p. m.
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This is the fourth group of printed lessons supplementing the U. S. Radio Farm School talks from broadcasting stations listed on inside of cover. All regularly enrolled students in the livestock, poultry, and dairy sections will be furnished the full series of booklets. These publications are mailed at the completion of each short course



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1927

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DAIRY=HERD MANAGEMENT

Lesson No. 1. Building Up the Herd

In building up a herd of dairy cows proper management is equally as important as feeding and breeding. If herds are not handled in the proper manner, feeding and breeding will fall far short of accomplishing the best results. The three points are largely dependent upon one another.

Building up the herd to best advantage requires definite policies. Diseases must be combated; the cows must be properly sheltered; dry cows and fresh cows need care suitable to their different conditions; records must be kept; and above all, expenses must be kept down.

Two Ways of Obtaining the Herd

There are two ways of obtaining high-producing dairy cows. One method is to buy them; the other is to breed them.

While it is possible to buy good cows at reasonable prices in sections having a surplus of purebred or high-grade cows for sale, it is only in exceptional cases good business for a beginner to purchase a large number. Often he is limited in funds; he does not understand the principles of proper feeding and breeding; and in a majority of cases he does not realize that high-producing cows must have better care and management than ordinary cows or they, too, may become low producers.

A Good Way to Start

It is usually better practice to start with a small number of cows and use a good purebred bull. The cows should be handled well and the most promising heifers selected to build up the herd. After a time, when finances permit, one or two purebred females may be purchased as a foundation.

In the meantime considerable knowledge will have been gained in care and management, and danger of financial loss will have been reduced to a minimum. This may seem like a slow method, but it certainly is the soundest and the surest. Breeders are not made in a day. It takes several years of intelligent effort and thought to build up and maintain properly a good herd of cows—either purebreds or grades—and the business can not be learned in a few months.

Individual Selection Important

The breed of dairy cattle selected is of little importance. Several breeds, the most important of which are the Ayrshires, Brown Swiss, Dutch Belted, Guernseys, Holsteins, and Jerseys, are being used in the United States, and all have proved satisfactory.

In making the selection the possible advantages of the different breeds should be studied. Local conditions, the market, and personal preference should be considered. There are good cows and poor cows in all breeds. For this reason individual selection within the breed should receive as much attention as the selection of the breed itself.

A bulletin describing the different breeds can be procured by writing to the United States Department of Agriculture.

Breeds Should Not Be Crossed

Breeds of dairy cattle should never be crossed. The present breeds are the result of many years of intelligent breeding along definite lines. By this method breeders have developed certain valuable characteristics which are transmitted with uniformity when animals of the same breed are mated.

When the breeds are crossed the characteristics of both breeds are so mixed in the offspring that they are not passed on to future generations with any degree of certainty.

A purebred sire, if possible a proved sire, should always be used. The better the bull the better the future herd will be.

Purebreds Produce More than Grades

Purebred cattle on the average produce more than grades. Records obtained by the Bureau of Dairy Industry for over 48,000 cows in cow-testing associations in the United States showed that purebred cows produced an average of 296 pounds of butterfat and 7,667 pounds of milk. Grade cows gave an average of 281 pounds of butterfat and 6,999 pounds of milk. The purebreds excelled the grades by an average of approximately 15 pounds of butterfat and 450 pounds of milk.

While the difference as shown by these figures does not appear to be large, it must be borne in mind that these 48,000 cows were in cow-testing associations. Ordinarily, grade cows are culled much more closely than purebreds. The grades whose records are given here really represent the best of their class.

Purebred Blood Essential

Purity of breeding, however, does not always insure greater or more economical production. Many herds of carefully selected grade cows produce as much or more than purebred herds of the same breed.

Over 90 per cent of the dairy products of this country are produced by grade cows, and this will continue to be the case for many years to come. However, it is the purebred blood in our grade cows that makes them high producers. This is the strongest argument we have for purebreds.

Start with grades, buy a purebred female or two as a foundation, and build up a high-producing herd either of purebreds or grades. Begin preferably in a small way. You will profit from the experience

gained as your herd grows in numbers and quality. This is good advice in any kind of business, and it surely applies to dairying.

Lesson No. 2. Handling the Dry Cow

That a cow should be dry for a certain period has been shown to be sound economic practice. This dry period serves four important purposes:

(1) It gives a rest to the organs concerned in milk secretion; (2) it allows the nutrients of the feed to be used for the development of the unborn calf instead of for the production of milk; (3) it enables the cow to replenish her stores of minerals which may have become depleted through the year's production of milk; and (4) it allows the cow to build up a reserve of body tissue before calving. This will be of great service to her later on, especially if she is a good producer.

Length of the Dry Period

The proper length of the dry period will depend upon the quantity of milk which the cow has produced during the year and upon her condition with regard to flesh. Carefully performed experiments indicate that the more milk a cow produces the greater is the depletion of the stores of nutrients used in milk secretion and the longer the dry period required.

Cows of low or of medium production should be dry for a month to six weeks if they are in good flesh. If they are thin, they should be dry a little longer. For high producing cows, a dry period of two months is probably best. This period of rest is not a loss to the dairyman, as the results will be seen in increased production in the next lactation period.

Have Cows in Good Flesh at Calving Time

Every man accustomed to handling dairy cows knows that ordinarily they will lose flesh for three

or four weeks after dropping a calf. The reason is that they can not eat enough feed to provide for both the milk flow and the maintenance of their body weight. In order, then, that the cow may not become too thin after calving it is necessary that she carry a considerable amount of flesh at calving time.

Cows in good flesh will also start off the milking period at a higher level of production than thin cows. This results in a greater milk yield for the year. There is no economy in having cows thin at calving time.

Proper Feed at Dry Period

The feed during the dry period should be high in minerals, especially lime. Experiments have shown that this is the mineral element most likely to be lacking in the cow's body. Good pasture in summer and properly cured legume hay in winter will supply lime.

A considerable amount of protein is needed in the feed at this time for the proper development of the unborn calf. The oil meals, bran, and other high protein feeds should make up a considerable portion of the ration.

A ration of equal parts of corn meal, wheat bran, ground oats, and cottonseed meal or linseed-oil meal is excellent. The quantity of feed given should be enough to bring the cow to a proper state of flesh at calving time.

Suggestions for Drying Off

Most cows can be dried off by gradually lessening the frequency of milking; that is, first miss one milking, then miss two, then three, etc.

When the daily production is only 6 or 8 pounds (less than a gallon), milking may be stopped entirely without danger. After this nothing should be done to the udder to stimulate the secretion of milk. Any milk that is left in the udder will be absorbed in a short time. With cows that are difficult to dry off, however, it may be necessary to cut down the amount of feed, especially grain, during this period.

Care During Gestation

Cows heavy with calf should be handled carefully to prevent injury. Slipping on stable floors or on ice in the lot may injure them and cause them to abort. They may also be injured by crowding through doorways or mounting other cows that may be in heat. All cows in heat should be confined by themselves or at least separated from cows heavy with calf. In other ways pregnant cows may be handled like the rest of the herd.

A week or 10 days before a cow is due to calve she should be watched closely, because she may need special attention during calving. If assistance is needed, it may be necessary to call in an experienced neighbor or veterinarian.

If calving occurs during the winter, the cow should be placed in a clean, roomy, well-bedded box stall. Sometimes the udder becomes so large and swollen that it may be necessary to draw out some of the milk before calving occurs. This is seldom necessary.

The cow should be kept as quiet as possible and fed a laxative ration at this time. Wheat bran and linseed-oil meal are especially good. Feed but very little hay or other roughage.

Lesson No. 3. The Fresh Cow

A comfortable, dry box stall with plenty of bedding should be provided for a cow about to calve. Immediately after calving it is good practice to give the cow a drink of warm water and follow this with a warm bran mash or an equal mixture of bran and oats. This is especially important in cold weather. A blanket will also prevent her getting chilled. If she gets chilled at this time, the after-birth may not be passed readily, and her vitality may be so lowered that disease germs gain a foothold. After the bran mash or the mixture of bran and oats, she should be given some good hay but should not be forced to eat it.

If the afterbirth is not passed within 48 hours, only an experienced person or veterinarian should

remove it, as an inexperienced person may do more harm than good.

Treatment for Congested Udder

If the udder is congested, a sufficient quantity of the colostrum, which is the first milk of the cow, should be milked out to give relief; but it is thought best not to milk the udder dry for a day or two after calving. This may help in the prevention of milk fever. If there are any signs of this disease, treatment should be given. Symptoms are nervousness, weakened condition, and a tendency to lie down.

After a couple of days, if everything is going nicely, the calf may be removed from the cow and the cow placed in the milking herd. Her milk will not be fit for human use for a week or 10 days. It should be fed only to the calf.

Guides for Feeding

Small amounts of grain should be fed for a few days. As the cow's flow of milk increases the amount of grain should be increased. She should be supplied with all the good roughage she will eat. With good producers about three weeks should be taken to get them on full feed. It is better to give too little concentrates during this period than too much. Too large a quantity will hinder the reduction of swelling in the udder and may cause digestive trouble.

Kindness Pays Dividends

It might be well to say something at this time about kindness to cows. They should be treated with kindness at all times. Cows so handled are easy to work with and do not get excited at calving time. Kindness pays in dollars and cents.

Cows Freshening in Fall the Best Producers

We have been discussing the care of fresh cows and dry cows. The question now comes up as to which

season of the year is best to have cows freshen. There appears to be a direct relation, on the average, between milk and butterfat production and season of the year in which cows freshen.

From a study of over 10,000 production and income records of cows freshening at different seasons the Bureau of Dairy Industry found that on the average cows freshening in the fall months produced the most milk and butterfat and returned the most income over cost of feed.

Winter freshening cows ranked second in these points, while those that calved in the spring and summer produced the least milk and butterfat and returned the smallest income over cost of feed.

Cows that calve in the spring usually give a big flow of milk during the summer months when feed is cheap. However, butterfat is usually low in price at that season. Then, too, the spring-freshening cow is very likely to get a severe setback in production when the heat, short grass, and flies appear. It is difficult to get her back to high production during the fall and winter. She must, therefore, be carried through the winter at a low production on expensive feeds.

Advantages of Fall and Winter Freshening

There are several advantages in having cows freshen in the fall and winter. Butterfat is usually high in price in those seasons, labor is easier to obtain, and there is more time to attend to the large amount of milk and to the calves.

A fall-freshening cow will, as a rule, produce well during the winter months, falling off in production as spring opens. At this time, the spring pasture becomes available and serves as a stimulus to increase or at least maintain production during the spring and early summer.

The period of low production will come during July and August, when conditions at best are not favorable for high production.

Fall-dropped calves are easier to raise and less subject to diseases. It is undesirable to have cows

freshen during the summer months on account of the hot weather, flies, and dried up pastures.

The dairymen who sell their milk to city retail trade should naturally have their cows freshen at all seasons of the year in order to keep up a steady flow of milk. This point is not so important for dairymen who separate the milk, sell cream, and use the skim milk for feeding purposes.

Lesson No. 4. Milking

You have all heard the slogan that some localities have adopted as a means of increasing the number of dairy cows. This slogan is: "It is Time to Milk." Many a boy has left the farm and gone to the city to work because of that expression. Many dairymen have spent considerable sums of money in buying and developing herds only to become disgusted with the milking.

Cows ordinarily are milked twice and sometimes three or four times per day. If they are persistent producers, the milking period may extend over a period of 10 or 11 months. This lesson will attempt to point out some practices which, if followed, make milking more pleasant and profitable.

The Question of Regularity

It has commonly been assumed that cows should not only be milked at the same time each day but that they should also be milked by the same person.

Experiments at the Beltsville, Md., farm of the Bureau of Dairy Industry show that milking may be done at irregular hours, without any marked effect on the production of average-producing cows. What effect irregularity of milking would have on high-producing cows has not been determined.

It was further found that when irregular milking was accompanied by irregular feeding the production was lessened by about 5 per cent.

Apparently cows are affected more by changes in the feeding routine than in variation in the hour of

milking. It must not be thought, however, that regularity is of no importance. However, if milking can not be done at the usual time, a small variation from this will not materially lower the production. The same can be said of changing milkers.

Frequent Milking Increases Production

The oftener a cow is milked, within certain limits, the greater will be the production. This accounts for the fact that many cows on official test are milked oftener than twice daily.

Experiments at the Beltsville farm indicate that for short periods three times a day milking gives an increase in production of 12 per cent over twice a day milking. In a year the increase would probably be about 18 per cent. Milking four times daily gives a further increase of 6 or 7 per cent.

The amount of increase will naturally vary with individual animals and seems to depend upon the quantity of production and the capacity of the udder. When the udder becomes distended milk secretion is checked.

In some dairies all the cows are milked three times daily, while in others only the higher producing cows are milked that often. Whether or not it will pay to milk three times per day will depend upon cost of the extra milking and the value of the increased milk.

It must be borne in mind in this connection that about 1 pound of concentrated feed will be required for each 2 or 3 pounds of extra milk produced.

There are two methods of milking cows, namely, by hand and by the mechanical milker.

Milking by Hand

In hand milking the milk should be drawn as quickly as possible, in a sanitary manner, and with the least pain or discomfort to the cow. Some milkers are rough, use too strong a grip, or have finger nails which are too long and sharp. This keeps cows uneasy, which may lead to lowered production and kicking.

There appears to be no advantage in milking cows slowly. In fact, the Wisconsin Agricultural Experiment Station has shown that the percentage of butter-fat in the milk may be lowered by prolonging the milking.

Advantages of the Mechanical Milker

The mechanical milker saves labor, makes milking easier than when done by hand, and for many persons makes the task more agreeable and pleasant. It is possible to produce milk with a low bacteria count by the use of a milking machine properly cleaned and sterilized.

As far as quantity of production is concerned, the mechanical milker seems to give as good results as ordinary hand milking. It is the general practice for a hand milker to follow the mechanical milker to draw any remaining milk in the udder.

The cost of installing a milking machine and the amount of labor required to keep it in a sanitary condition, however, makes it impractical if herds are very small.

It has been claimed that machine milking causes udder troubles. With the earlier models of machines there was, no doubt, some ground for such claims, especially if they were left on the teats too long. Modern makes and styles lessen the likelihood of such trouble.

Failures with mechanical milkers are usually due to carelessness of operation, lack of mechanical knowledge, and improper cleaning. The increased use of mechanical milkers indicates their practicability.

Lesson No. 5. Keeping Records of the Herd

Dairymen who do not keep feed and production records of their cows will never realize the greatest profits.

The system of keeping records need not be elaborate, but it should be detailed enough to furnish accurate information on production of individual animals and quantity of feed eaten. Breeding dates

should be recorded, and a plan of identification and registration of purebred animals should be followed.

Milk-Production Records Essential to Profits

The principal reason for keeping milk-production records is to show definitely which cows are profitable and which are not. The inferior cows can then be disposed of and the better ones kept for production and breeding purposes.

Daily milk-production records are necessary if proper feeding methods are to be used. Cows should be fed in accordance with the amount of milk they produce, which can be known only by weighing the milk each day. Sickness or other abnormal conditions in cows are often evidenced by a glance at the daily milk-record sheet.

Equipment for Daily Milk Records

To keep daily milk records the only equipment necessary is a supply of milk-record sheets and a spring-balance scales for recording daily milk weights. Such scales are equipped with adjustable hands, so that the weight of the bucket balances the scales. Thus the weight of the milk can be read directly.

The scales should be hung in a convenient place in the barn or milk house, where each cow's milk can be weighed and recorded in only a few seconds.

A milk scales can be purchased from any dairy supply house at a cost of not more than \$5, and is probably one of the best investments on a dairy farm. A year's supply of milk sheets can be bought for a few cents.

Test for Butterfat

At regular intervals each cow's milk should be tested for butterfat. A common practice is to make a composite sample of the milk from each cow by taking samples of each milking for three consecutive days about the middle of each month and test this for butterfat.

The percentage of butterfat thus obtained is used as the average test for the month, and the total amount of butterfat produced is calculated by multiplying this test by the total amount of milk as shown on the milk-record sheet.

Other methods may be used, such as weighing and testing the milk for one day during each month or every other month. Such methods give results very near the actual butterfat production.

If a dairyman is a member of a cow-testing association, detailed production and feed records of the cows are kept by the cow tester hired by the association. This is a cheap and reliable method of keeping such records.

The national dairy-cattle breed associations, in cooperation with the respective State agricultural colleges, maintain systems of official testing for dairy cows.

It matters little what system is used so long as the facts obtained are reliable, thus eliminating the element of guesswork.

Breeding Records Important

Breeding records of the herd should also be kept. The date of breeding each cow, the bull to which she was bred, and expected date of calving should be recorded in permanent form.

For convenience it is also well to have a gestation table handy in estimating the date of calving. If a gestation table is not available, count back three months from date of service and add 10 days.

For example, if a cow is bred on March 10, by counting back 3 months and adding 10 days the probable date of calving will be December 20. The gestation period for cows is approximately 283 days.

Methods of Identification

When a calf is dropped or a new animal added to the herd it should be assigned a name and herd number. Many breeders use fiber-disk ear tags on which

the number is stamped. These tags are about the size of a quarter and can be attached to the ear with an ordinary hog ringer. They are not easily pulled out and are not confused with the small metal tags placed in the ears for identification purposes in tuberculin testing.

The practice of slitting the ears for identification purposes is not recommended. It is a cruel practice and does not add to the beauty of the animal.

A strap around the neck, to which is attached a numbered metal tag, is also used. Straps will last for several years, and there is little likelihood of their becoming lost. Any dairy or livestock supply house can furnish numbered identification tags.

Tattooing numbers and letters in the ears is practiced by some breeders and is required by some of the breed associations for identification in connection with official testing. Tattooing outfits can be purchased. If properly done, this method is reliable and durable. On dark-skinned breeds, however, the tattoo marks do not show up distinctly.

Register the Calves

Registration papers for all purebred animals should be on hand. Calves should be registered as soon as practicable. The national dairy-cattle breed associations furnish directions and advice for registering dairy cattle.

Addresses of Associations

The names and addresses of these associations are as follows:

American Guernsey Cattle Club, Peterboro, N. H.

American Jersey Cattle Club, 324 W. 23d St., New York, N. Y.

Ayrshire Breeders Association, Brandon, Vt.

Brown Swiss Cattle Breeders' Association, Beloit, Wis.

Holstein-Friesian Association of America, Brattleboro, Vt.

Lesson No. 6. Testing for Production

With the growth of dairying in the United States, several systems of testing dairy cattle for production have been developed. In fact, it might be said that testing has been the chief means by which the increase in higher average production per cow has been made possible. It is the yardstick or ruler by which production is measured and upon which selection is based. Without testing, a dairyman never really knows whether the production of his cows is increasing or decreasing.

Why Cow-Testing Associations Have Grown

Almost all dairymen will agree that testing is an important item in proper herd management, but only comparatively few of them are willing to do this testing themselves in a systematic and regular manner. It is primarily for this reason that cow-testing associations have grown and developed so rapidly.

The Plan and Methods of Associations

The plan is simple. In a regular cow-testing association 15 to 25 or more farmers adopt a standard form of constitution and by-laws and agree to put a certain number of cows, usually their entire herd, on test for a year.

They hire a tester, who visits the farm of each member once a month and weighs, samples, and tests the milk of each cow. This tester also makes the various calculations and keeps a record of the feed consumed by each cow. In other words, he keeps the farmer's herd record book up to date.

The cost to the farmer varies from \$36 to \$50 per year, depending upon the size of the herd and the salary paid the tester. Modifications of the regular cow-testing association methods are in use, all of which aim to furnish sufficient information on the production of individual cows in the herd to enable the owner to select the high producing ones and to feed them properly.

Register of Merit and Advanced Registry

While both purebreds and grades are tested by means of cow-testing association records, purebreds may also be tested by means of the Register of Merit and Advanced Registry, which are referred to as official testing.

This method has been in use for some time. It serves as an incentive for the development of purebred animals and as the basis on which most of the breeding animals are selected. It is also a big factor in determining the value of these animals. It differs from the cow-testing-association plan in that the testing is done by a representative of the State agricultural college and the record is authenticated by the particular breed association and officially recognized by it and by the public in general. In other words, the record is official.

Practically the same plan is followed by the different breed associations, although the requirements for each breed vary a little. The various classes and minimum production requirements are fixed by each breed association.

The State agricultural colleges or experiment stations have charge of conducting the test in the State in which the cow or cows are to be tested. Thus the responsibility for the accuracy of the test is assumed by these institutions.

How to Obtain Official Testing

If a breeder desires to have one or several purebred cows tested, he applies to the breed association, which then requests the State agricultural college in that particular State to conduct this test.

The college then sends to this breeder's farm a test supervisor, who carefully watches each cow milked, weighs and samples the milk, and makes a test for butterfat. He then makes out a complete report of each cow's production and the per cent of butterfat in the milk for the period of time covered by his supervision.

The supervisor is a disinterested person. He is hired by the college and receives his orders and salary from it. The farmer pays the college for this service. Costs vary in different States.

In former years much of the official testing was conducted over short periods of time, usually 7 or 30 days. These short-time tests have now largely given way to tests for longer periods usually covering a lactation period.

The Herd Test Plan

Recently the Ayrshire Breeders' Association inaugurated the herd test plan, which is really a combination of the cow-testing association and official testing plans. Its main features are that it includes both feed and production records; the entire herd, both purebreds and grades, is on test; and it is considerably cheaper than official testing.

Proves Bulls for Herd Sires

During recent years, investigations have strikingly brought out the fact that in order to secure a constant improvement in production through breeding, it is essential that proved bulls be used as herd sires.

In order to prove a bull, comparative production records of both his daughters and their dams must be kept. Unfortunately many bulls have been killed or otherwise disposed of before such records are available. Cow-testing association records and official records are being used more and more for the purpose of proving bulls.

Testing Regulations Uniform

The essential features of the regulations governing all testing are the same in all States. However, the State colleges have some leeway in carrying out the details. This has caused a slight variation in the way testing is done in different States. For this reason those who wish more detailed information about any of the plans discussed should write to their State agricultural college.

Lesson No. 7. Stable and Yard Arrangement and Equipment

Stall and Manger

The construction of the stanchion, stall, and manger should depend on the arrangement of the cows in the stable. If the herd is large enough, two rows of stalls will be most economical, as less labor for feeding the cows and for handling the manure will be required than if the stalls are in one long row.

Whether or not, with two rows, the cows face the inside central alley or the outside of the barn will depend largely on individual choice.

When the cows face in, feeding takes less time than when they face out, as a feed cart can be pushed up the central alley and both rows of cows fed at one trip. Then, too, sunlight coming in from the windows along the outside wall will strike the gutter, thus tending to keep down foul odors.

When the cows face out, removing the manure is made easier, because it can be taken from both gutters in one trip. This will usually permit a central driveway wide enough for a manure carrier or a spreader. By this arrangement the sunlight from the windows strikes the mangers, thus keeping them from getting musty.

Concrete Manger Best

The concrete manger is to be preferred, because it is easy to keep clean and will last indefinitely if properly built. If built without high fronts, it can be cleaned more readily. On the other hand, if the manger does not have high fronts the cows may push the feed out of the manger into the alley and slip and bruise their knees when reaching for it.

The stanchion or tie should be of the nonrigid or swinging type, as this allows more freedom and comfort to the cow. Wooden ties can be made at home, or metal stanchions can be bought. Stall divisions may prevent cows from stepping on one another's teats and udders when lying down or getting up.

Floors

Wood, concrete, or cork brick is recommended for stall floors. A wooden floor is warmer than one made of concrete, but it is not so durable and sanitary. Concrete floors are easy to clean and are very durable, but they get cold in winter. This may cause udder trouble or rheumatism. By using plenty of bedding, however, this may be overcome. Cork brick floors also are sanitary, durable, and easily kept clean, but the first cost is high.

Stable floors should be kept as clean as possible by thorough and frequent washing. However, it must be kept in mind that floors will not dry so quickly in cold weather as in warm weather. It is unhealthful for cattle to lie on wet floors, even if plenty of bedding is used.

Dimensions for the Gutter

The size and arrangement of the gutter largely govern the ease with which cows are kept clean. The gutter should be at least 8 inches deep on the platform or stall side and 6 or 7 inches on the opposite side. It should be at least 16 inches wide. It should slope to drains and the drains provided with perforated covers to prevent bedding and other material from clogging the sewer.

Pure Fresh Water Essential

An ample supply of pure, fresh water is essential either in the barn or in the barnyard near by. Some dairymen prefer to water their cows from a trough on the outside, even in winter. In many cases tank heaters are installed to warm the water.

Many barns are equipped with individual drinking cups in each stall. This system provides a constant supply of fresh water for the cows at all times.

Salting

Dairy cows should have all the salt they want. The quantity eaten will vary with the kind of feed and the size of the animal. Many dairymen mix from

1 to 2 pounds of salt with each 100 pounds of grain mixture. An additional amount of salt should be provided, so that the cows may have access to it in order to take more if desired. Stock salt can be purchased in many forms.

Bedding

Cows are bedded for three reasons: (1) To provide a comfortable bed, (2) to keep the cows clean, and (3) to absorb the liquid manure. Common bedding materials are wheat straw, oat straw, corn stover, shavings, and sawdust.

Good bedding should be bulky, have high water-holding capacity, and contain fertility. Corn stover and the straws are more bulky than shavings or sawdust and also have higher fertilizing value. Shavings are cleaner and more nearly free from dust than other bedding material, and for this reason are frequently used in dairies where very clean milk is produced.

Disposal of Manure

All manure should be removed from the stable at least once a day and should be spread on the land as soon as possible after it is made. However, at certain seasons of the year when other farm work is pressing manure hauling must be delayed. For this reason a covered storage house or manure pit should be provided to prevent excessive loss of fertility through leaching.

The most common way of removing manure from the barn in medium-sized dairies is by the litter carrier suspended from an overhead track. The carrier may be dumped directly into a manure spreader or wagon standing outside the barn, or may go to the manure pit.

Feeding Methods

The quantity of grain to be fed should be determined for each cow. A general herd mixture may be made up and proper quantities weighed out to each cow.

The most practical method for feeding grain is to place a sufficient quantity in a truck or cart and weigh or measure the amount for each animal as the cart is pushed through the feeding alley. Silage may be fed from the same cart or from a similar one.

A small blackboard or feeding card showing the quantity of feed each cow is to get may be attached to the cart. A spring balance scales suspended on an arm above the feed truck will be helpful.

Baled hay is convenient for feeding. Care should be taken that cows do not get pieces of baling wire in their feed. It is best to cut the wire with a pair of wire clippers rather than with a hatchet or axe. If loose hay is fed it should come down in a separate room or feed room to avoid dust in the barn. This room should be conveniently located so as to require as little work as possible.

Cows should be fed regularly. Grain is usually given before or during milking and hay and silage afterwards. About half the feed should be given in the morning, the other half in the evening. If cows are milked oftener than twice a day, the grain feeding should correspond; but the roughage may be fed twice a day.

Grooming

No dairyman should permit his cows to remain dirty. Brushing cows not only adds to their appearance but also makes possible the production of clean milk. Grooming should be done sufficiently long before milking to allow the dust to settle.

Exercise

It is good practice to let the cows out of the stable at least once a day, except in very bad weather, even if this is not necessary for watering. The stables are more easily cleaned and bedded when the cows are out, and this is a good opportunity to notice any cows that may be in heat. As far as production is concerned, a cow needs no more exercise than she will get by walking at will in a small lot.

Lesson No. 8. Feeding and Management of the Bull

In order that bulls may give the best possible service it is highly important that they be fed and managed intelligently. Then, too, many dairy sires are dangerous to handle, and precautions should be taken to avoid being injured by them.

Feeding the Bull Calves

Bull calves should be fed and handled much the same as heifers; that is, started on whole milk and then changed gradually to skim milk and supplementary feeds. Bull calves, however, grow a little faster, and should, therefore, be given a little more feed than heifers of the same age. If skim milk is plentiful, it will pay to continue feeding some of this until they are 8 or 10 months old.

Never let bulls become stunted in growth, because it is impossible to tell whether small size is due to heredity or to lack of feed. Separate the bull calves from the heifers before they are 6 months old, as they may begin then to get the heifers with calf.

Rations for the Mature Bull

Bulls should be of sufficient size and maturity for light service at 12 months of age. From this time on their grain ration may be much the same as the regular herd mixture for cows. They should be given enough to keep them in a vigorous physical condition, but should not be too fat, as they then become slow and sluggish. This is especially true of older bulls. If bulls get too fat, the grain should be cut down materially.

From 4 to 10 pounds of grain daily should be fed, depending on the size and condition of the bull and the kind of roughage he receives. A good grain mixture for bulls in heavy service is 300 pounds ground oats, 200 pounds wheat bran, 100 pounds ground corn or barley, and 100 pounds linseed-oil meal.

Legume hays, including alfalfa, clovers, vetches, soybeans, and cowpeas, since they are high in protein and minerals, are best for keeping bulls in good condition. From 10 to 20 pounds daily is sufficient. Spoiled, musty, or left-over hay from the herd should not be fed. They may be given 10 to 20 pounds of silage daily without injuring their breeding powers.

Bulls should receive plenty of pure water. The best method of supplying this is by means of a tank in the bull pen.

Housing

In providing houses and pens for bulls, the main points to keep in mind are (1) safety and ease in handling, (2) comfortable stable for protection from weather, and (3) provision for exercise.

A shed or barn opening into a yard is most practical. The shed may be left open on the south side, except in the coldest climates. It should be large enough so that the bull can move and turn freely. It is advisable that the shed contain a strong tie and feed manger. A feeding alley in front separated from the pen will permit feeding without entering the pen.

Various devices and contrivances may be used in the barn and pen to insure greater safety in handling bulls. The Bureau of Dairy Industry of the United States Department of Agriculture will send upon request a plan showing the construction of a bull shed and pen with safety features.

Build a Strong Fence

A bull should not be put in a yard or pasture that does not have a strong substantial fence. After he has once broken through a fence it is much harder to keep him in.

The fence should be 5 or 6 feet high, so that the bull can not jump over. Woven wire, barbed wire, heavy planks, rails, and iron pipe with concrete posts are commonly used for bull fences.

If barbed wire is used, the posts should be about 8 feet apart, the wire stretched tight, and the strands spaced from 8 to 12 inches apart.

Five-foot heavy woven wire, with one or two strands of barbed wire on top, makes a good fence. Poles or rails are practical and cheap on farms where they are available.

Reinforced concrete posts with iron pipes run through holes in the posts make a strong pen that will last a long time if properly constructed. However, such a fence is expensive to build.

Be sure that all gates are strong and equipped with reliable locks and catches.

Methods of Exercising

Many bulls, after their value has been proved, are found to be sterile or slow breeders due largely to close confinement in a stall or pen and lack of exercise. But even when a large pen is provided, many bulls are lazy, and it may be necessary to force them to take exercise. Various methods and devices are used for this purpose.

Some breeders make a practice of yoking up the bulls and working them like oxen. They can often be profitably used on work about the farm, such as plowing, hauling manure, and pulling stumps.

The treadmill can also be used, but it is not always satisfactory, because the bull may refuse to walk on the tread unless he is constantly watched and may learn various tricks of stopping the mill. Then, too, if the tread becomes wet and slippery he may fall and injure himself.

If two or more bulls are kept, they may be turned out together. This results in their getting considerable exercise, especially if they are young. If bulls are turned out together, they should be dehorned.

Many bulls will get a great deal of exercise if they are given a strong empty barrel or keg to bunt or roll around the pen. Oftentimes such a device may be hung from a rope or chain low enough so the bull can butt it.

If an exercise pen is not available, a bull may be tied to a ring which slides on a suspended cable. A revolving sweep may also be used.

Service

Bulls are old enough for light service when 10 or 12 months old, but they should be bred to only a few cows until they are 18 months old. At 2 years of age, during the breeding season, a bull should be able to serve 4 or 5 cows a week without injury. Ordinarily, a mature bull should not serve more than 2 cows in one day nor more than 75 or 80 during the year.

A breeding rack will be found very helpful and will prevent injury to the cows, especially if the bull is exceedingly heavy.

It is ordinarily not good practice to let a bull run with the herd. If he does, some heifers will undoubtedly be bred too young. Then, too, it is impossible to keep accurate breeding records.

Ring

A ring in the bull's nose is a safeguard in handling. Every bull should be ringed even if he is regarded as gentle and easy to handle. Between the ages of 8 months and 1 year is the best time to ring the bull. A copper ring 2 to 2 $\frac{1}{4}$ inches in diameter is satisfactory at this time, but it should be replaced by a larger and stronger gun-metal ring when he is 2 years old.

The bull calf should be trained to lead, first with a halter and later with a staff attached to the ring in his nose. Bull staffs can be purchased. Be sure you get a strong one, equipped with a locking device and a handgrip.

Safety in Handling

Always handle a bull in a firm manner and never trust him. Many persons have been killed or permanently injured as a result of taking chances. No matter how quiet and gentle a bull has been, he is likely to be in a bad humor at times. Never take a bull on a public highway unless he can be kept under absolute control.

Feet and Horns

Bulls kept in close quarters with little exercise frequently develop long hoofs. These are unsightly, painful, and prevent the bull from walking or standing squarely.

The feet of young animals can be trimmed with a long-handled chisel while they are standing on a hard dirt or plank floor. It is often necessary, however, to throw and tie old animals and trim their feet with pinchers, saw, and hoof knife.

In general, bulls to be kept for sale or show should not be dehorned, because it is likely to affect their selling price. If old bulls are properly handled, it seldom becomes necessary to dehorn them. This, however, is often done to make an unruly bull easier to handle.


Unless the horns are removed by caustic before the animal is a week old, bulls should be at least 2 years old before the horns are taken off, otherwise there is danger that false horns or scurs will develop. It is best to have a veterinarian or other experienced man do the dehorning.




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Dairy Short Course No. 5

ENGINEERING

January 28, 1927, to

March 18, 1927

By Specialists of the Bureau of
Dairy Industry

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*By Specialists of the Bureau of
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This is the fifth group of printed lessons supplementing the U. S. Radio Farm School talks from broadcasting stations listed on inside of cover. All regularly enrolled students in the livestock, poultry, and dairy sections will be furnished the full series of booklets. These publications are mailed at the completion of each short course



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ENGINEERING

Lesson No. 1. Essential Features in Dairy-Barn Construction

K. E. PARKS

The plan, construction, and equipment of a dairy barn should receive careful consideration and study in order that the building may save time and labor for the farmer and provide comfortable quarters for the cows.

Dairymen should become familiar with the best principles of barn construction and the most satisfactory types of equipment before building or remodeling their barns.

The subject covers such a large field that only the principal features of modern construction and equipment will be presented in this brief lesson.

Detailed descriptions and plans may be found in Farmers' Bulletin 1342, Dairy-Barn Construction.

The most common types of modern dairy barns are the one-story cow stable, with feed in a separate building, and the two-story barn, in which the feed is stored on the floor over the cows. Certain features are common to all types of dairy barns, and these will be described in this lesson.

Points to Consider When Selecting the Site

A dry, well-drained building site should be selected.

If possible, the building should be placed with its length extending north and south so that the interior of the barn will receive the greatest possible amount of sunlight. The barn should be so placed in relation to other buildings that the sunlight can enter freely.

A windbreak of trees or buildings on the north side or in the direction of the prevailing cold winds will be found a great advantage in winter.

The barn should also be conveniently located for unloading hay and feed and filling the silo. It is very inconvenient to have to drive through gates and yards to fill the silo or feed barn, and with careful planning it is generally possible to arrange the yards so that this will be unnecessary.

A cow stable has certain features, such as light, floor space, ventilation, air space, stalls, mangers, and gutters, which are generally recognized as important.

Plan for Plenty of Sunlight

Sunlight is considered essential to the health of the dairy cow, and it also tends to destroy disease germs which may be found in dark and dirty stables. It is necessary, therefore, that ample window space be provided.

Four square feet of glass per cow is desirable, and a much larger amount is preferable, except in extremely cold climates.

Windows should be well distributed so that the stable will be uniformly lighted. The height of the windows should always be greater than their width, as more floor area is exposed to the sun in this way than with low, wide windows.

In cold climates objection is sometimes made to the use of too much glass on account of the loss of heat through the windows. This difficulty may be remedied by using storm sash in the winter or by using double-glazed sash; either of these is better than small windows, which do not flood the barn with sunlight.

Ventilation

While the amount of cubic air space per cow in a stable is not necessarily an indication of either good or bad ventilation, it is considered desirable to have not less than 500 or more than 1,000 cubic feet for each animal. In the North from 500 to 600 cubic feet is sufficient. The stable may be uncomfortably

cold if more air space is provided than can be kept at a reasonable temperature by the body heat of the animals.

In the South 1,000 cubic feet per animal is more satisfactory, because of the long period of warm weather.

A good ventilating system should be installed. This subject will be treated in a separate lesson.

Stalls and Platforms

The usual width of a stall is $3\frac{1}{2}$ feet between centers of stall partitions, but it may vary from 3 to 4 feet.

The length of the cow platform is usually from $4\frac{1}{2}$ to 5 feet, depending upon the size of the animals to be accommodated. Sometimes a very large cow needs a little longer platform.

As there are cows of different sizes in the same breed it is a common practice to vary the length of the platform from one end of the row of stalls to the other.

For the smaller breeds this variation is from 4 feet 4 inches at one end to 4 feet 8 inches at the other, and for the larger breeds from 4 feet 8 inches to 5 feet.

The length of the cow platform is measured from the inside of the stanchion curb to the edge of the manure gutter.

The Gutter and the Manger

The shape and size of the gutter and manger may vary.

The gutter is usually from 7 to 9 inches deep and at least 16 inches wide. The bottom of the gutter should slope a little from the stall platform. It should also slope to a drain.

The manger should be about 2 feet 6 inches wide, the back of which should slope forward, away from the cow.

The Concrete Floor

For the cow-stable floor concrete has become well established as the best material in alleys, driveways,

gutters, and mangers. It is durable and may be kept clean with the least amount of labor and expense.

Concrete is also commonly used for the cow-stall floor; and while there are objections to its use for this purpose, it answers very well when plenty of bedding is used.

Cork bricks, wooden blocks, and planks are also used for stall floors.

With concrete, either a plentiful supply of bedding should be used or a removable plank overlay should be provided for each stall. This overlay may be used during the winter and taken up in the summer.

Plank floors bedded permanently in the concrete are not satisfactory, as they soon become insanitary.

How to Lay Cork Bricks and Wood Blocks

Cork bricks are sometimes used for stall floors. Formerly the bricks were laid with a 4-inch concrete curb at the edge of the gutter, but many cows have been injured on this kind of curb. When an angle iron curb is used in place of the concrete no trouble is experienced.

Creosoted wood blocks are also used for cow-stall floors. They must be laid in hot asphalt or pitch, as they swell when wet, and would not have proper allowance for expansion if laid in cement.

Especial care should be exercised in laying the concrete floor of a dairy barn. A floor which is not properly pitched to drain, and is not properly finished, will be a constant source of annoyance, and may result in injury to some of the animals.

Specifications for Concrete

In driveways and alleys the floor should be 6 inches thick, the base being 5 inches, and the top finish 1 inch thick. All other parts of the floor may be 5 inches thick, with a 4-inch base and a 1-inch finish.

The base may consist of 1 part Portland cement; $2\frac{1}{2}$ to 3 parts clean, coarse sand; and 5 parts broken stone or screened gravel. The finish should be 1 part cement and 2 parts sand.

The manger and gutter should be troweled smooth and hard on the surface with a steel trowel, while all alleys where the animals have to walk should be floated with a wood float.

When the cement has partially set it should be marked off in squares or thoroughly roughened. Roughening these walks is very important, as the animals are liable to slip if the concrete is troweled smooth.

Directions for Proper Drainage

In a stable not over 50 feet long the whole floor, including mangers, stanchion curb, cow platform, gutters, and alleys, should have a fall of about 1 inch in 10 feet from one end of the building to the other. In longer barns it may be desirable to pitch from the ends to the center.

At the low end a drain should be provided from the manger to the gutter, and a gutter drain connected to glazed terra-cotta sewer pipe to carry the wash water away from the building.

These drains should be fitted with brass or wood plugs, and the gutter drain should have a water-sealed bell trap if the sewer pipe is connected to any sort of a cesspool or other sewage-disposal plant.

Sewer tile under the stable floor should be run in straight lines with a fall of one-fourth inch per foot. The tile should be carried out from under the building as directly as possible in order that it may be easily cleaned if it becomes stopped up.

When Planning Provide for Equipment

The subject of stable equipment will be treated in a separate lesson. However, if it is desired to install equipment, such as litter and feed carriers, milking machines and hay hoists, consideration should be given to their installation while the building is being planned to avoid unnecessary cutting and fitting to erect the equipment.

Blue prints of various dairy barns may be obtained free of charge from the Bureau of Dairy Industry, United States Department of Agriculture, and from many county agents.

In requesting barn plans full information should be given indicating the number of cows to be housed, whether facing in or out, and whether a one-story or two-story barn is preferred.

If a one-story barn is desired, state whether space is available in present buildings for feed and young stock, and if not, plans for a feed barn should be requested.

Lesson No. 2. Principles of Dairy-Barn Ventilation

A. B. NYSTROM

To maintain health, fresh air is as essential for animals as for human beings.

Ventilation in barns and other buildings in which stock are kept is just as necessary as a health measure as in homes, schools, factories, and other buildings in which human beings live or work in more or less close quarters.

The importance of ventilation of cow stables has been recognized as a result of the increased demand for clean, wholesome milk at low cost of production. To satisfy this demand, it is necessary that each cow shall produce as much milk as possible.

In order to increase production, breeders have developed the high-producing cow, and a greater winter production of milk has been sought.

Large winter production requires that tightly built shelter for the cows be provided, particularly in the colder sections of the country.

Tightly constructed barns are apt to be damp unless ventilation is provided; and the stabling of animals in dark, poorly ventilated, damp barns affects their health and helps to spread disease among the stock.

Clean, wholesome milk can be produced only from healthy cows.

Poor Ventilation Causes Many Losses

Tests have shown that the quantity of milk yield is affected by sudden changes in the temperature of

the barn. These are avoided by a well-regulated ventilation system.

Poor ventilation causes a barn to be damp or wet. This in turn may cause losses due to the molding of feed stored in the buildings, the rotting of timbers, or the rusting of equipment.

The air which an animal breathes is as necessary a part of its food as is the hay or the grain eaten. Within the body neither assimilation of the food nor generation of energy can take place without oxygen.

On an average a cow breathes 116 cubic feet of air per hour. If we had to give the cow her air in a 10-quart pail, as we sometimes give water, it would take about 6 pailfuls a minute to meet her requirements.

A Good Ventilating System Necessary

The cow not only needs air but she needs pure air. Air once breathed has lost much of its value. Ventilation means the furnishing of pure air.

The system of ventilation commonly used in cow stables is known as the King system, from its originator, Prof. F. H. King, of the University of Wisconsin.

This system is designed to remove the foul air from the stable and at the same time provide for the entrance of fresh air without causing a direct draft on any animal. The system operates on the principle that warm air, being lighter than cold air, tends to rise, while cold air tends to settle.

Specifications for a Good System

In constructing such a system each outlet flue should have an area of approximately one-fifth square foot per cow, with possibly less area in cold climates and more in warm climates; that is, a flue having an area of 1 square foot should be considered sufficient for 5 cows, and a flue 2 feet square, having an area of 4 square feet, would provide enough fresh air for 20 cows.

The area of outlet flues is based on the principle that the air will rise in the flue at a certain rate or

velocity, thus removing from the stable a certain number of cubic feet of air per minute. An equal amount of fresh air is drawn in through the inlet flues, thus establishing air circulation and maintaining a certain standard of air purity in the stable.

The velocity of the air depends not only on the difference in the temperature of the air inside and outside the stable but also on the wind which blows across the top of the outlet flues and the action in the flues.

Keep Outlet Flues in Good Order

While the amount of foul air removed by the flues may vary considerably, the cows continue to give off a constant supply of foul air and moisture.

If the outlet flues are not working properly, the foul air will not be removed and the moisture will condense on the walls or ceilings, causing the stable to be damp and unhealthful for the cows. This condition, however, is more likely to occur in a stable which has no ventilating system, and it is not wise to depend on window ventilation alone.

One or two large outlet flues of sufficient area are more efficient than a number of smaller ones of equal area.

Outlet flues should be air-tight and as straight as possible, because bends in the outlet flues cause air friction which greatly reduces the flow of air. If bends are necessary, the area of the flue should be increased accordingly. The outlet flue should start at the ceiling.

Arrangement of Intake Flues

The fresh-air intakes should be small in area and should be placed from 7 to 10 feet apart, or, where necessary, 12 feet apart along the side walls.

Intake flues should be so arranged that the openings on the outside of the building through which the air enters the flues are at least 5 feet below the openings into the stable. The latter openings are placed just below the ceiling. This prevents the warm air near the ceiling from leaving the building through the

intake flues as it would do if the outside opening were at the same height or higher than the opening inside the barn.

Proportion of Intake to Outlet

In extremely cold climates the intake should be less than the outlet, but under most conditions the total area of all the inlet flues should be approximately equal to the total area of the outlet flue or flues.

For example, if the outlet flue has an area of 4 square feet, the total area of the intake flues should equal 4 square feet. A barn with one outlet flue 4 square feet in area would probably have five inlet flues on each side, or 10 in all, each having an area of one-tenth of 4 square feet, or 57.6 square inches.

Inlet flues 4 inches wide and 16 inches long would be of proper size for a one-story frame barn having 4-inch stud walls. A flue of this size could be arranged between studs placed 16 inches apart.

On the outside of the building the intake flues should be protected from the weather by a hood, and dampers should be provided on the inside openings at the ceiling to permit closing some of the intakes when necessary.

In barns that are plastered on the inside these flues should be protected with suitable insulating material between the flue and plaster; otherwise any moisture which touches the walls at the points where the flues are located will condense.

Construction of the Outlet Flue

Outlet flues may be constructed of wood or of galvanized iron. The iron flue should be covered with insulating felt, especially in very cold climates.

Outlet flues act like chimneys, and the higher they extend above the roof the greater will be the draft.

Dampers may be provided in straight flues having too much draft but should not be placed in short flues or those containing many bends or other obstructions to a free circulation of the air above the roof. Such a damper is commonly made of galvanized iron.

The outlet must be covered to keep out rain and snow, and the cover must be so shaped that the wind blowing across it will not make a draft down the flue instead of up.

In a properly designed ventilator the wind will create an outward suction and thus assist in removing the foul air from below.

The old-style slatted cupola is not a satisfactory ventilator, as it is liable to give a down draft when the wind blows.

Ventilators especially designed for stable use are on the market.

Lesson No. 3. Construction of Farm Dairy Houses

ERNEST KELLY

A milk room separate from the stable is necessary. Milk is easily contaminated by dirt and absorbs odors very readily. It should therefore be removed promptly to a clean, airy place, free from dust, insects, and objectionable odors.

Location

The best results will be obtained if the milk room does not open directly into the stable. On the other hand, if the milk room is far removed from the stable it will take much additional labor to carry the milk from each cow directly to the milk house.

Prompt removal is desirable so that the milk will not be subjected to stable contamination and will be cooled quickly.

If proper surroundings are maintained, it is not objectionable to build the milk house directly adjacent to the stable but with an outside entrance.

The milk house should be located on a well-drained spot. No accumulations of manure, refuse, or other objectionable material should be allowed near the building. They give rise to undesirable odors and attract flies.

The House

A concrete, brick, or tile house with an asbestos-shingle or slate roof is fireproof, durable, and sanitary. Stone and cement block also are used. While the initial cost of such a house may be higher than one made of wood, it is believed to be cheaper in the long run, for it requires few repairs and no painting.

The roof may be covered with slate, asbestos shingles, tile, prepared roofing, wooden shingles, or metal.

Outside walls should be of approximately the following thicknesses: Concrete, 6 to 8 inches; brick, 9 inches; tile, 8 inches; stone, 14 to 18 inches; cement block, 8 inches; and frame, 6 inches.

The Floors

Particular care should be used in constructing milk-house floors. Concrete is by far the best material for this purpose as it resists moisture, decay, and wear.

Concrete floors should be built of a base made up of 1 part cement, 3 parts sharp, clean sand, and 5 parts stone. This base should be about 5 inches thick and should be covered with a top coat 1 inch thick made by mixing 1 part cement and 2 parts sand. The top coat should be troweled hard and smooth.

To provide thorough drainage, the whole floor should be pitched at least one-fourth inch to the foot to one or more large bell traps.

The Inside Finish

Cement plaster (1 part cement to 3 parts sand) makes the best inside finish, and this can be applied directly to the walls if they are composed of stone, tile, concrete, brick, or cement blocks.

If the house is of frame, it is necessary to use expanded metal lath on which to plaster.

Dressed tongue-and-groove lumber may be used for inside finish, but its life is not so long nor is it so sanitary as the plaster. Such an interior should be kept well covered with a good white enamel paint.

Provision for Sunlight

All milk houses should have plenty of sunlight, well distributed. Window-glass surface equivalent to at least 10 per cent of the floor area is necessary.

A building 10 by 20 feet, for example, should have windows with a total glass area amounting to at least 20 square feet. It is advisable to have counterbalanced or sliding sash so that screens may be placed on the outside without interfering with the operation of the windows.

Ventilation

Steam and water are apt to make the dairy house damp. This hastens deterioration and favors the growth of mold and bacteria. Odors are also likely to arise from spilled milk.

To keep the air dry and sweet proper ventilation is necessary. A ventilating flue is desirable. This should run from the ceiling out through the peak of the roof, the outer opening being shielded to keep out rain and snow.

All openings such as doors, windows, and ventilators should be completely screened to prevent the entrance of flies and other insects. Insects carry disease germs, which may get directly into the milk, or may be deposited on the clean cooler, strainer, and other utensils.

Milk houses should be supplied with an abundance of cold running water for cooling milk. In addition they should have adequate facilities for hot water and steam; for, without these, utensils can not be properly washed and sterilized.

Disposal of Waste

Every milk house should be provided with a proper means of waste disposal. More or less milk is spilled on the floors or washed off the utensils. Milky water swept out of the milk-house door attracts flies, and gives rise to disagreeable odors.

The floor should be drained through bell traps into a drain of 6-inch glazed tile. Four-inch tile is some-

times used, but this is apt to become clogged. The drain should be laid 2 feet deep, and should have a fall of at least 1 foot to every 60 feet in length. A rapid fall tends to prevent clogging. Drainage should be carried well away from the milk house.

Persons contemplating the construction of dairy houses, especially waste-disposal systems, should apply to their local and State health departments for copies of regulations on sanitary requirements. These requirements vary somewhat in different States.

Information regarding plans for dairy houses may be obtained from the Bureau of Dairy Industry, United States Department of Agriculture.

Lesson No. 4. Essential Features in Silo Construction

A. B. NYSTROM

The kind of silo to build will depend upon the kind of material available. The most permanent types are the concrete, tile, brick, and stone. Other common types are the stave, plastered, and wooden hoop silos. Pit and trench silos are also used to some extent.

Plans for different types of silos, showing details of construction, may be obtained without cost from many of the agricultural colleges and from the Bureau of Dairy Industry, United States Department of Agriculture. In requesting plans, specify the kind and size of silo desired.

Four Important Essentials

Regardless of what kind you build there are certain essential features to observe in building any silo.

1. The walls should be air-tight, since the keeping of silage depends upon the exclusion of air. In wooden silos the lumber should be well matched and contain no large knots. A wash of cement or raw coal tar thinned with gasoline is effective in making a concrete silo air-tight. Care should be taken that the doors fit closely into their frames.

2. The walls should be smooth and plumb so that in settling the silage will not stick to them and thus cause air spaces in the outer edge of the silo; furthermore, the side walls should be capable of standing considerable strain without cracking or bulging. This is one reason why square silos are unsuccessful.

3. The silo must be so deep that the pressure from above will thoroughly pack the silage and force the air out. The greater the pressure the less air is left in the silo and the less will be the loss of food materials by fermentation.

4. The only form of silo to be recommended is the round one. Taking into consideration the amount that it will hold, this form is the cheapest; and the walls are more rigid than those of the square and many-sided forms. This results in better preservation of the silage.

Location

The silo should be placed outside rather than inside the barn. As a silo ordinarily does not need the protection of a barn, it is not economical to use barn space for this purpose. The most popular location is not more than a few feet from the barn and opening into a separate feed room. The door leading from this room to the barn can then be closed and the silage odors kept out of the stable.

Except for the underground types, the silo should not be built in the ground so deeply as to make it necessary to lift the silage more than 5 feet in getting it out from the bottom. In other words, the bottom should not be more than 5 feet below the lowest door.

How to Determine the Diameter

The diameter of the silo depends upon the quantity of silage to be fed daily.

The silage should be removed from the top at the rate of $1\frac{1}{2}$ to 3 inches a day, depending upon the outside temperature. The warmer the weather the more silage must be removed from the surface daily in order to prevent spoiling.

A common error in building is to make the diameter too large for the size of the herd. The weight of a cubic foot of silage varies according to the height of the silage, but in a full silo 30 feet high it averages about 40 pounds. So, by knowing the quantity of silage to be fed daily, it is possible to estimate what the diameter of the silo should be to permit the removal of a certain number of inches in depth each day.

A 900-pound cow ordinarily consumes 30 pounds of silage a day and a 1,200-pound cow about 40 pounds. Yearlings eat about one-half as much as mature animals; fattening cattle, 25 to 35 pounds for each 1,000 pounds live weight. A sheep takes about one-eighth as much as a cow, and horses should be limited to 15 or 20 pounds daily.

Rules Governing the Height

The height of the silo will depend on the amount of silage needed during the silage feeding season. In general, the height should not be less than twice nor more than three times the diameter. On account of the pressure from above, the greater the depth the better the silage. If the silo is less than 24 feet in height the quality of silage will not be the best. Because of the excessive amount of power required to elevate the cut corn into the silo, a very great height is to be avoided.

The Foundation

The foundation of the silo should receive special consideration, since a large part of the silage, as well as the weight of the walls, must be supported by it. The foundation should have its base on firm soil and should extend below frost line. In the North it should be placed 4 feet or more below the surface of the ground and 2 feet below in the South.

The base of the foundation must be wider in loose soils than in clay soils to prevent the walls from cracking and settling out of shape. The width of

the foundation wall varies from 10 to 30 inches, depending upon the character of the soil and the size of the silo.

The Floor

If the earth in the bottom of the silo is firm and comparatively dry, no provision need be made for drainage, and a floor is unnecessary. A concrete floor, however, will make the silo easier to clean and make it impossible for rats to burrow underneath the foundation wall and gain access to the silage.

On the other hand, if the earth in the bottom of the silo is inclined to be seepy, a tile drain should be laid in it and a concrete floor laid above the tile.

The tiling should open into the floor in the center and the floor should be made to drain to it. The entrance of the tile drain should be stopped with a loose fitting wooden plug when the silo is about to be filled and should be kept open when the silo is empty.

The Doors

Ample provision should be made for reinforcing that part of the structure near the doors. The door should form an air-tight joint with its frame. Tar paper is often useful for that purpose. The door should be flush with the inner wall of the silo so that air pockets will not form as the silage settles.

Doors should be of such size as to permit a man to enter easily, and they should be so close together that the silage will not have to be lifted any considerable height to remove it. The usual size is about 20 inches wide and 30 inches high, and the space between the doors $2\frac{1}{2}$ to 3 feet. The lowest door should not be more than 5 feet above the bottom of the silo, and less than this is desirable.

Many silos are now built with continuous doors, which are more convenient for the removal of silage. These are obstructed only by the hoops or bars extending across the opening. These crossbars are necessary to prevent the door frames from spreading.

A chute should be built over the doors to prevent scattering of the silage when thrown down. This makes it possible to catch all the silage in a truck.

A ladder should be attached to the silo at one side of the doors or in the chute. Sometimes the reinforcing rods of the continuous door or the hoops may be used as a ladder.

A Roof Advisable

Although a roof is not essential to the keeping of silage, it is for several reasons advisable to equip the silo with one. A roof adds to the appearance, life, and stability of the silo; it retards freezing; it keeps rain and snow out, making the work of removing the silage more agreeable; and it will also prevent the silo from becoming a feeding ground for pigeons.

The roof should have a door large enough to admit the blower from the cutter. A simple trapdoor answers the purpose, but a hinged dormer window with glass is preferable.

Write for a List of Materials

One of the main questions which will confront the farmer who undertakes to build his own silo is, What materials shall I need and how much of each kind? Owing to the variation in size of silos it is impracticable to give such information in detail here.

If any farmer who desires such information will address a request to the Bureau of Dairy Industry, United States Department of Agriculture, Washington, D. C., or to its local representative, stating the size and kind of silo he intends to build, a complete list of the materials needed will be forwarded to him free of cost.

Lesson No. 5. The Calf Pen

A. B. NYSTROM

Calves need clean, comfortable quarters. Many dairymen, however, seem to think that any corner of the barn, no matter how dark or poorly ventilated, is satisfactory for a calf pen.

It is well to keep in mind that the heifer calves of to-day will be the cows of to-morrow, and that any setback in growth because of illness or lack of proper feed and shelter will result in low milk production when the animal matures. The best stables and pens are none too good for the calf.

In planning the stable not only the health and comfort of the calves should be considered but also the convenience and saving of time of both the farmer and his wife.

Proper Dimensions for the Pen

Calves should be allowed to run loose in the pen, and fastened only while being fed. Each calf should be allowed about 30 square feet of space. For example, if a maximum of 10 calves are to be kept in one pen, the dimensions should be about 10 by 30 or 14 by 22.

The long narrow pen is better than the square pen for several reasons. It allows greater opportunity for exercise in case the calf can not be turned out because of bad weather, permits sunlight to reach a greater part of the floor of the pen, and more room will be available for stanchions along one side.

Provide Plenty of Sunlight

If possible place the pen so that the sun can shine into it during a large part of the day.

Use glass windows that can be opened and closed, and have these high enough so that a draft from the open window will not blow directly on the calves.

Although the amount of window light will vary with the location, allow at least 6 square feet for each calf.

One continuous window running the whole length of the pen is preferred. The lower part of the window opening should be about 4 feet from the floor.

Ventilation and Doors

Since the windows are usually kept closed in extremely cold weather, it is well to provide intake and outlet flues for ventilation, as was mentioned in a previous lesson on ventilating dairy barns. In warmer weather it may be necessary to provide still more ventilation than is afforded by windows and doors. For this purpose the wall next to the yard should be so constructed as to allow it to be raised or removed entirely, thus making an open shed out of the stable.

Permanent doors leading to the exercise lot should be provided. In pens 30 or more feet long there should be two doors, one at each end. More doors are needed for longer pens. This will allow for partitioning the space inside so that the large calves may be separated from the small ones.

The Floor

The floor of the calf pen should be made of material that is waterproof and easily cleaned. Concrete floors, cork brick laid in concrete, and wooden blocks laid in asphalt are very satisfactory. No gutter is needed, but a slight depression at one side leading to a floor drain is desirable for drainage, and the floor should slope toward this depression at a pitch of about one-eighth inch to the foot.

Stanchions

In fastening the calves for feeding, the rigid stanchion is probably the best method to use. This may be either of wood or of iron pipes. The stanchions should be arranged at least 2 feet apart in a row next to an alleyway. This will make it possible to feed the calves without entering the pen. The number of stanchions should be sufficient so that all calves can be fastened at one time.

The Manger

The manger may be of wood or concrete. It should be about 12 inches wide with sides about 4 inches high and should extend the full length of the row of stanchions. It is well to have the bottom of the manger several inches off the floor.

If a wooden manger is used, hinge the side next to the alleyway to the bottom. This will make cleaning easier. If the manger is of concrete, provide drains for cleaning. These should be covered with strainers.

Partitions in the mangers will prevent the calves from sucking one another's ears after feeding. These partitions must fit the manger rather snugly, should be about 32 inches high, and constructed so that they may be lifted out while the manger is being cleaned.

Removing Manure

A calf pen needs to be cleaned often. For this reason arrangements should be made to remove the manure conveniently. When a wheelbarrow is to be used for this purpose, the doors of the calf pen must be wide enough to provide for this. If the carrier system is installed in the main cow barn it should be extended to the calf pen.

One word of precaution should be given here. Never throw the manure out into the yard where the calves must walk over it. From the standpoint of the health of the calf, as well as that of sanitary milk production, the manure should be removed daily to the fields or to a properly built manure shed or pit.

The Exercise Lot

Calves need exercise. Let them have it out of doors if the weather permits. A well-drained lot should be provided. To insure good drainage this should be covered with cinders or gravel to a depth of several inches. A clay floor in a calf lot is not satisfactory.

The size of the lot will naturally vary with the amount of space available, but it should be several times as large as the inside pen or stable. Provide shade at one end if possible. Fence it with woven wire or boards. Do not use barbed wire.

Lesson No. 6. The Properly Planned and Constructed Bull Pen

J. B. SHEPHERD

Because of their nervous temperament and great strength, mature dairy bulls must be handled with care.

The properly planned and constructed bull pen, with attached exercise yard and conveniently located breeding rack, makes possible the safe and easy handling of bulls.

With such a pen it is possible not only to give the bull better care and thus prolong his period of usefulness, but also to keep proved sires that would otherwise have to be disposed of because they have become unruly.

This system, with various modifications, is in use on many farms.

The bull may be housed in a corner of the main barn or, if more desirable, in a separate stable.

Complete housing equipment for a bull with the pen built into a one-story building designed for that purpose will be described in this lesson.

Stable Construction

A one-story stable 12 by 18 feet in size is sufficiently large to provide a pen 11 by 12 feet and an inside feeding alley 5 by 11 feet. The feeding alley makes it possible to feed the bull or confine him without going inside the pen.

The building should have a substantial concrete foundation, with the footing below the frost line, and a concrete floor 4 inches thick, including the usual cement finish to make it more nearly waterproof.

Roughening the surface of the floor will prevent the animal from slipping. This should be done when the floor is being finished. The floor should slope to a bell trap in one corner at a pitch of one-fourth inch to the foot. The trap should lead to a 4-inch tile drain.

Two doors are necessary, one opening into the feeding alley and the other opening from the bull pen into

the exercise yard. The latter door should be 4 feet in width.

Sufficient light and ventilation will be furnished by four single-sash windows, each having six 9 by 12 inch panes. The lower side of these windows should be at least 4 feet from the floor. Two of them should be placed on the south side.

In cold climates the walls of the stable should have sheathing and paper under the weatherboarding and should be lined on the inside with tongue-and-grooved material. The windows should be fitted with hinges.

In warm climates, the stable may be single sided and left open on the south. If this is done, a heavy plank fence and gate should be constructed in place of the wall.

Bull Pen and Feeding Alley

The pen is equipped with a manger and stanchion placed in one corner next to the feeding alley. A small gate between the pen and feeding alley is of great convenience to the bull keeper.

The partition between the pen and feeding alley, as well as the gate itself, may be constructed of planks, or iron piping, placed vertically.

The corner manger may be constructed of wood or concrete and the stanchion made sufficiently wide so that the bull can easily reach his feed.

The stanchion should be rigid, one side being a movable bar or pipe hinged at the bottom with a suitable latch at the top. A rope could be attached to the top of this stanchion, making it possible to fasten the bull from the feeding alley.

The door between the pen and exercise yard should be hung on a track, and guides provided at the bottom to keep it from swinging in. Equipped with ropes and pulleys, the door can also be operated from the feeding alley and the bull confined in the pen or kept outside in the yard as desired.

A grain bin and wall cabinet located in the feeding alley are added conveniences.

If water pressure is available, a hydrant with stop-and-waste cock located below the frost line could also be provided.

Exercise Yard

The exercise yard should be large, well drained, and the surface free from stones. It should be inclosed with a strong fence 5 to 6 feet high.

A number of suitable materials and proper fence construction were described in Lesson No. 8 of Dairy Short Course No. 4. Solid fences that obstruct the view are not advisable.

Ordinarily gates form a weak place in the fence and should be placed only where absolutely necessary. They should be strongly built, hung on heavy hinges, and equipped with reliable locks and latches. A post or other rigid support should be set against the free end of the gate so that it will not open outward.

A small tank placed in one corner of the yard allows the bull to drink whenever he desires. In cold climates it may be necessary to provide a tank heater.

Breeding Rack

The breeding rack is very helpful, especially with heavy bulls. This rack consists of a stall and a stanchion into which the cow is led for breeding.

On each side is an incline with cleats on which the bull rests his feet when he mounts. The weight of the bull is on the rack and not on the cow. It may be constructed so that the stanchion can be moved forward or backward according to the size of the cow.

The rack should be placed close to the exercise yard and in such a position that the cow can be fastened in it, and the bull let in from behind by simply opening a gate. After the bull has backed out, the gate can be shut from the outside.

Complete plans and specifications for the bull pen and breeding rack may be obtained by writing to the Bureau of Dairy Industry, United States Department of Agriculture, Washington, D. C.

More detailed information on the housing equipment of dairy bulls is given in Farmers' Bulletin 1412, Care and Management of Dairy Bulls.

Lesson No. 7. Cow Yards and Manure Sheds

A. B. NYSTROM

Farmers who are planning to build new barns should give some attention to the location and arrangement of the cow yards in order to make the work of handling the herd as easy as possible and at the same time provide comfortable and sanitary quarters for the animals.

For farmers who already have their barns and yards laid out, the following suggestions may be helpful in rearranging the lots and lanes to bring about the desired results.

Drainage of First Importance

Drainage should be one of the first considerations.

When a herd of cows is inclosed in a small pen the ground is likely to become very muddy if the water from rains or seepage does not drain off readily. Therefore, a good slope from the barn is desirable.

This should be provided even if it is necessary to haul in several loads of dirt and gravel. The latter is by far the better material. If it is used, however, care should be taken that the pieces of stone are fine and also packed down well so that small stones will not get between the toes of the cows' hoofs and cause lameness. A small amount of clay might well be added to the gravel to act as a binder in cementing the material.

Concrete barnyards are desirable because they are permanent and very easily kept clean. In many places at least a part of every barnyard might well be constructed of concrete. On steep hillsides concrete should not be used on account of the danger of the cows slipping when the ground is covered with snow or ice.

Windbreaks Desirable

The location of the barnyard with respect to windbreaks is also important. Some sort of protection such as a natural hedge or board fence should be pro-

vided on the side from which cold winds may come. This is usually on the north and west.

A good plan is to have open sheds on at least a part of these two sides of the cow yard. These sheds should be open on the sides next to the yard. They will provide protection not only from winds but also from cold rains and snow during the time when the cows are turned out for exercise.

Other Considerations Affecting Location

Other considerations in locating the cow yard are the matters of unloading hay, filling silos, and manure disposal.

Under no conditions should the manure pile or the manure pit be in the cow yard.

Although the silo might well be inside the yard, provisions for gates from the fields should be such that driving in and out with loads of feed will be convenient.

When filling the silo it should be necessary to open only one or two gates, and the lanes should be so located that the cows can be shut out of the yard at such times.

Naturally the cow yard should not be near the milk house or the wells that furnish the water supply for the house and barn.

Guard the Wells

If it is unavoidable to have the yard around the well, be sure that the well is fenced off and that a water-tight curb extending 6 or 8 feet below the surface be placed over the well to prevent surface water from entering. A concrete water-tight slab should also be placed over the well and curb, and the yard should be graded so that drainage will be away from the well.

Satisfactory Gates

The gates leading to the lanes and from one cow yard to another should be swung on heavy gate hinges and so constructed that they will not sag.

They should be about 12 feet long and may be constructed of iron or wood.

A satisfactory wooden gate may be made of 1 by 6's, using about five 12-foot boards for horizontals, with three double crosspieces for vertical braces, one at each end, and one in the middle.

To prevent sagging, nail on two diagonal 1 by 6's. These also should be double. One should extend from the bottom of the hinge post to the top of the center vertical brace. The other should extend from the bottom of the center brace to the top of the swinging end of the gate. If hung on a solid post with strong hinges a gate made in this way will not sag.

Three Good Fences

Fences for cow yards or corralls may be of 2 by 6 planks, woven wire, or iron pipes set in concrete posts.

The plank fence, if made of good-quality lumber and kept painted, should last 12 to 15 years.

Wooden posts may be of cedar, honey locust, or any other variety of wood which does not rot quickly. The base of all wooden posts should be treated as an aid in preventing decay.

Boards may be fastened to the posts with large nails or bolts. Nails are quite satisfactory if the ends of the boards are protected by an extra 1 by 6 upright nailed on each post. Be sure to nail the boards on the inside of the pen.

The fence should be four boards high. Place the lowest board about 12 inches from the ground and space the other three about 6 inches apart. This will make a fence about 4½ feet high, which is about right for a cow yard.

Bull fences should be at least 5 feet high.

A very durable and attractive fence can be made of four rows of 2-inch iron pipe set in concrete posts 8 feet apart. Specific instructions for making such a fence can be obtained from dealers in cement.

A woven-wire fence is satisfactory if the grade of wire is good and the mesh not too large. It should be 4½ feet high, with one strand of barbed wire on top.

For lanes and pastures woven wire is especially well adapted, but for a smaller inclosure, such as a cow yard, the woven-wire fence is not so satisfactory as either the board fence or the iron-rail fence.

Manure Disposal

The manure shed should be at least 100 feet from the barn. For certified milk production the requirements are 300 feet. In any case it should be large enough to permit storing the manure when it is impossible to drive on the land.

Manure should be hauled to the fields as often as possible for sanitary reasons and because it decays quickly, resulting in the loss of plant food.

Protect Manure from Seepage

When manure is to be stored provisions must be made to protect it from rains and seepage. A properly constructed roof will keep out the rain, and a concrete floor with side walls about 4 feet high will prevent loss through seepage.

The shed should be constructed in such a way that the manure spreader can be driven into it for loading. When the manure can be applied directly to the soil the spreader may be placed in the shed and the manure dumped into it directly from the carrier, thus saving a considerable amount of handling.

If manure must be stored in the summer, it is well to have the sheds screened as a precaution against the breeding of flies.

Dimensions for the Shed

The size of the shed will vary in accordance with the length of time necessary to store the manure.

For a herd of 20 cows and for storage of not over three months the shed should be about 20 feet wide and 25 feet long. In such a shed it will be necessary to stack the manure only about 6 feet high.

Blue prints of a manure-disposal system may be obtained by writing to the Bureau of Dairy Industry, United States Department of Agriculture.

Lesson No. 8. Dairy-Barn Equipment

J. B. SHEPHERD

The modern dairy barn, with its numerous large windows, its well-planned ventilating system, its durable and sanitary floors, its sanitary gutters and drains, is not complete without the addition of proper dairy-barn equipment.

Such equipment makes barn work easier, aids in keeping the barn clean, and adds to the health and comfort of the dairy herd, thereby creating favorable conditions for the production of sanitary milk at a minimum expense for labor and feed.

A consideration of dairy-barn equipment should begin at the time the barn is being planned in order that the desired installations may be made and unnecessary cutting and fitting avoided.

The sanitary regulations of cities also affect the amount and type of equipment necessary to be installed where market milk is sold.

Equipment is necessary for stabling the animals, storing feed and bedding, grinding feed, feeding, watering, clipping, currying, and milking the animals, barn cleaning, recording the feed consumed and the milk produced, fly control, tool storage, and fire protection.

Stabling Equipment

Stabling equipment includes stanchions or ties, stall divisions, box stalls, calf pens, and the bull pen also, if the bull is kept in the barn. Calf pens and the bull pen have been fully described in lessons 5 and 6.

The Stanchion

The most common method of confining the cows in the barn is by means of stanchions, which should be of the swinging type rather than the rigid. They are simple, sanitary, convenient, and hold the cows in alignment with the platform and gutter, thereby helping to keep the animals clean.

Stall partitions prevent the cows from stepping on one another and from crowding at feeding and milking time.

Stanchion and stall equipment may be made of either iron piping or wood. A yoke with several links of chain at each end allows the cow freedom and permits her to move her head from side to side. Iron piping is easily cleaned and offers no hindrance to the proper circulation of air.

The Box Stall

Box stalls are a necessity for sick cows and are often used for cows on test. They should be in one end of the barn away from the milking herd. If used as maternity stalls only, one box stall for every 10 stanchions will be sufficient.

The floor should be of concrete or some other durable material and provided with a drain. When used they should be heavily bedded with straw.

The sides of the stall may be constructed of either iron pipes or planks and should be at least 5 feet high. Ample room will be provided by stalls 10 by 12 feet in size.

A stanchion and feed manger should be built on the side next to the feeding alley.

Storing Feed and Bedding

With the exception of silage and roots, all feed and bedding are stored on the second floor of the dairy barn or, in case of a one-story barn, in a separate feed barn.

The grains are sometimes stored in other farm buildings and taken to the dairy barn after being ground.

If the grain is stored on the second floor of the dairy barn, grain bins are usually built at one end and space also provided for the storage of sacked mill feeds.

A feed grinder and mixed feed bins, together with a mixing floor, should be located conveniently to the grain bins.

The mixed-feed bins should have tapered, sloping bottoms terminating in a feed room on the ground floor so that the feed cart can be filled by gravity from grain spouts. If the grain is stored in a separate building similar conveniences should be provided. If a considerable amount of grain is to be stored, a grain elevator of the chain and bucket type would save labor. Both the grain elevator and the feed grinder could be operated by an electric motor, gas engine, or farm tractor. If a gas engine is used it should be located in a separate room or building.

A hay track with fork or slings is necessary for hoisting the hay and bedding into the mow. If the hay is stored over the cow stable a closed hay chute extending to the floor of the feeding alley should be provided.

Roots for fall and winter feeding may be stored in a basement under the barn or in a separate root cellar. This storage room should be frost proof and well ventilated. A root cutter which may be operated by hand or belt power should be provided for slicing the roots.

Feeding

The work of feeding livestock is materially lessened by the use of feed carriers or trucks. The carrier is hung from a track very much like a hayfork or litter carrier, and the truck has two small wheels underneath the center and a swiveled castor at either end.

A spring-balance scale attached to the feed cart makes it possible to weigh accurately the amount of grain for each cow.

Hay is bulkier than grain or silage and is usually forked from the hay chute to the cows. If the hay must be carried a considerable distance and the feed alleys are wide enough, a large hay cart would save considerable time and labor.

Watering

Plenty of good water to which the animals have frequent access is a necessity for the dairy herd. This may be provided by an outside tank or by individual watering cups in each stall and pen.

In cold climates tanks should be equipped with a tank heater. Watering cups enable the cow to drink at any time.

Barn Cleaning

The wheelbarrow is still being used on many farms in cleaning the dairy barn. On account of the labor saved, however, the litter carrier, which runs on overhead tracks or cables, is rapidly coming into use. If the track is properly located, every stall and pen can be reached readily.

Manure forks, shovels, heavy brooms, floor scrapers, and a length of hose complete the barn-cleaning equipment.

Clipping and Currying

Cleanliness of the dairy cow is important not only from the standpoint of the comfort and the health of the animal but also from the standpoint of clean milk production.

Currycombs and brushes are a necessity in a dairy barn for keeping the cows clean.

A clipping machine run either by hand or by motor power, if electricity is available, is desirable for clipping the hair on the tail, flanks, and udder.

Milking

For washing the udders of the cows and the hands of the milkers, a hydrant and washbowl should be placed in a convenient location if water pressure is available.

When milking is done by hand, small-top milk pails will aid in the production of clean milk.

Milking machines are coming into more common use. They have proved practical where operating directions are closely followed and the machines are properly cleaned and sterilized.

Recording Milk Production

A spring-balance milk scale and a daily milk-record sheet placed in a little milk room located just

outside the dairy barn will make it possible to determine the production of each cow.

The scale should have an adjustable indicator with a thumb screw so that it can be set at zero when the empty pail is on the hook.

Provision should be made for preventing the milk sheet from becoming soiled and unreadable.

Fly Control

Unless flies are held in check, they continually annoy the cows and fall into the milk. To prevent this, fly sprayers, flytraps, and shallow pans containing fly poison should be used in and around dairy barns.

More complete information on fly control and methods of constructing flytraps are given in Farmers' Bulletin 734, Flytraps and Their Operation.

Tool Storage

A closet containing a shelf and several heavy hooks should be provided for storing the numerous small pieces of equipment used in and around the dairy barn. It should have ample space so that all the equipment can be stored in a systematic manner.

Fire Protection






Properly grounded lightning rods should be installed on the dairy barn.

Fire extinguishers, inspected at least once a year and known to be in working order, should be kept in convenient places.

If the barn has a water-pressure system, the pressure should always be kept at a high level, and a quantity of serviceable hose and a nozzle kept in readiness for use.



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U.S. DEPARTMENT OF
AGRICULTURE

OFFICE OF INFORMATION—RADIO SERVICE

Dairy Short Course No. 6

BREEDING

January 28, 1927, to
March 18, 1927



*By Specialists of the Bureau of
Dairy Industry*

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This is the sixth group of printed lessons supplementing the U. S. Radio Farm School talks from broadcasting stations listed on inside of cover. All regularly enrolled students in the livestock, poultry, and dairy sections will be furnished the full series of booklets.

These publications are mailed at the completion of each short course



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BREEDING

Lesson No. 1. Principles of Breeding

G. W. HERVEY

The subject of heredity has always been one of universal interest. From remote times the problems connected with the breeding of livestock have received a great deal of attention.

Human requirements of food and clothing have been directly associated with the development of many different breeds and classes of livestock.

Although man recognized very early that the characteristics possessed by animals of one generation are transmitted to those of the succeeding one by some definite plan, yet improvement in the quality of his livestock was not made rapidly because the principles underlying heredity were not known. Even until recent times the familiar saying "Like begets like" sufficed to cover much of the ignorance of how inheritance is actually accomplished.

At the present time, due to scientific research, the facts of heredity are becoming better known. For this improved knowledge breeders of dairy cattle owe a great deal to the Austrian monk, Gregor Mendel, who, after experimenting by crossing different varieties of the garden pea, in 1865 advanced the law of heredity which now bears his name.

The results of Mendel's investigations were ignored until 1900, when his original paper was brought to light.

The rediscovery of Mendel's publication, together with other discoveries made at about the same time

concerning the breeding qualities of plants, was responsible for an added interest in the study of heredity, which has since constantly increased.

The ideas set forth by Mendel have been enlarged and extended to innumerable practical problems in the breeding of both plants and animals. To-day Mendelism merits the attention of the dairy-cattle breeder, because familiarity with at least its basic principles is necessary for the improvement of the herd in all details which are not governed primarily by nutrition or some other environmental agency.

Every potent animal is endowed with a capacity for transmitting its own characters. It may transmit bad characters as well as good.

The selection of parents in the expectation that certain desirable characters will appear in their offspring is the practical application of the Mendelian theory. Mendelism, therefore, is primarily the interpretation of breeding phenomena according to the law of chance.

We know from every-day experience that when certain events happen; or when two or more independent events happen at the same time, a variety of results may follow. Very often these results can be arranged into a table of normal expectation.

A common way of illustrating probability, as the term is used here, is afforded by the tossing of two coins. Suppose the coins are tossed 100 times. If they are not defective in any way, we may reasonably expect, on the basis of previous experience, 2 heads to fall by chance 25 times, head and tail 50 times, and 2 tails 25 times.

Every time the experiment is performed this exact ratio will not prevail, but there will be a tendency for it to be approached. The greater the number of times the coins are tossed the more nearly will the actual results secured agree with the theoretical.

In many respects the results attained in dairy-cattle breeding practice are exactly like those obtained from this operation of the law of chance. Let us consider for a moment a case which can be explained by Mendel's law.

Cattle are found in either a horned or a polled (hornless) condition. When individuals of a true-

breeding horned strain are crossed with polled, all the offspring, which are called *hybrids*, are without horns.

Sex has no influence on the results. It makes no difference whether a horned bull is mated with a polled heifer or the reverse. In either instance a *combination* of the hereditary qualities of both parents is effected in the hybrids with respect to condition of the horn.

When these hybrids are mated a *segregation* is noticed, according to a ratio of three polled animals to one horned. Polled and horned may be regarded as a pair of *alternative characters*. The polled condition, appearing three times out of four, is said to be *dominant*, while the horned condition, showing up only once out of four, is *recessive*. The normal ratio of 3 to 1 will not be observed every time a cross is made between hybrids of the type just mentioned, but with an increase in the number of cases under consideration it will become more evident.

Individuals recessive for a given character can transmit only the recessive condition. They are said to be pure or *homozygous* for the character concerned. Consequently, when two horned cattle are mated no polled offspring can be produced.

Especially interesting, however, are the animals which exhibit the dominant polled condition. The latter fall into two classes, including those which are pure for transmitting absence of horns to the succeeding generation and those which are mixed or *heterozygous* in their ability to transmit that character.

In appearance members of both classes are the same; but since they differ in their hereditary make-up, their offspring must differ in appearance. This is proved by the fact that when animals pure for the polled condition are mated, only polled animals are produced; but when animals mixed for that character are mated, the ratio of 3 polled to 1 horned is noted in the offspring, thus indicating that this ratio is in reality a 1-2-1 ratio, namely, 1 pure polled, 2 mixed polled, and 1 pure horned.

The phenomenon of segregation can be explained on the ground that the germ cells of parents contain

factors which determine the hereditary constitution of their offspring.

In the case just cited, when a new animal arises from the union of a male germ cell (sperm) and a female germ cell (egg), each carrying a factor for the polled condition, all the germ cells produced by such an animal must contain that factor. The same is true for an animal receiving factors for the horned condition from both parents.

Animals of the mixed dominant class, on the other hand, receive one factor for the polled condition from one parent and one factor for the horned condition from the other parent, so, in turn, are necessarily dual in their transmission of these factors to individuals of the next generation.

We have seen in our illustration that if grandparents differ in one character, two visible types are to be expected among the grandchildren.

If we were to select grandparents presenting two pairs of alternative characters instead of one, the grandchildren would show four visibly different types. Thus, as the number of character differences is increased, the probability of variation in the second generation becomes greater.

From our remarks it might be construed that hybridization is responsible for this variation. Although it certainly does bring it to pass, yet somewhere there must have been a beginning of these character differences.

Some authorities believe that the explanation lies in the fact that in the breeding of both plants and animals a new character sometimes appears unexpectedly. Such a character is called a *mutation*.

Mutations are of a permanent nature; that is, they behave as unit characters in the inheritance scheme.

All these points indicate that the hereditary qualities of dairy cattle offer a practical medium for studying problems of heredity, especially because of their economic bearing.

Available information relating to the inheritance of unit characters of the cow is limited in comparison with that recorded for small laboratory animals, such as rats and rabbits. This is due to the fact that the

study of the subject, from a truly practical standpoint, is still in its infancy; that time is required for working out detailed information experimentally; and that the cow is a slow-breeding animal with relatively few offspring for observation.

It is believed, however, that sufficient data have been collected to justify the belief that the main points of segregation and recombination upon which the Mendelian theory is based will prove to be true for characters connected with conformation, color, and production of the cow, as it has for that of other organisms.

It must not be understood that all cases of inheritance are explained as simply as the one that has been described. There are various special interpretations of the law. Many phases of the behavior of characters with respect to their transmission are exceedingly complex and require careful checking before definite information concerning them can be set forth.

Furthermore, in weighing the probable part that heredity plays, the effect of environment upon the individual must not be overlooked. Frequently, it is difficult to judge whether environment or heredity has been the determining factor in the appearance of an animal.

For example, a calf may become stunted through faulty nutrition and never attain its hereditary capacity for growth, or an injury early in life may be responsible for an undersized adult. Alterations of this nature, however, can not be regarded as heritable.

For the guidance of any who desire more information on the subject of heredity, the *Journal of Heredity*, published monthly by the American Genetic Association, Washington, D. C., is especially recommended. Attention is also directed to the following books:

Genetics and Eugenics, by Castle, Harvard University Press.

Principles of Breeding, by Sinnott and Dunn, McGraw-Hill Co.

Genetics in Relation to Agriculture, by Babcock and Clausen, McGraw-Hill Co.

Lesson No. 2. Practical Breeding

G. W. HERVEY

In our preceding discussion it was brought out that very often when two animals breeding true for a pair of alternative characters are mated, one of the pair appears and is known as dominant, whereas the other disappears and is known as recessive. It was also shown that in later generations there is a tendency for these characters to become segregated into their original parental forms.

In the practical breeding of dairy cattle this phenomenon is sometimes liable to give rise to complications and cause concern. This is especially true in connection with the inheritance of color.

For example, the breeder of Jerseys is apt to ask, "What causes a spotted calf to appear in my purebred herd?" Or the Holstein breeder may wonder why a red and white calf is born among his choice black and whites.

In such instances a segregation of characters is responsible for the appearance of spotting or red color, either of which is recessive, and indicates that somewhere in the ancestry there were spotted Jerseys or Holsteins with red color instead of black.

A condition of hybridization with respect to the color pattern concerned was thereby set up. The hidden character was really not lost from the ancestry, and it merely required the particular circumstance of a chance mating of two hybrid parents to result once more in one animal in four bearing the recessive color.

It is only fair to say that occurrences of this kind are not necessarily a reflection of inefficiency on the part of the herd owner, nor is the herd itself to be condemned too severely.

Segregation takes place even where the best of selection is followed. Often it reveals desirable features in the herd; but when it is a cause of color which is different from the requirements specified for a particular breed, individuals exhibiting the fault should be eliminated from the future breeding scheme.

Constant selection is essential for success in cattle breeding. Choosing animals showing desirable characteristics and rejecting those lacking them eventually fix good qualities in the herd. Perhaps nowhere does this practice have a better application than in breeding for improved milk and butterfat production. The process of developing a high-producing strain of cows, however, is somewhat more complicated than that of selecting and breeding for a special color or conformation pattern. This is due to the fact that the amount of milk produced by the cow is probably determined by several factors, each of which lends itself to segregation.

Investigations of herd records indicate that among these factors there may be some associated with the transmission of high production, possibly dominant in a Mendelian sense, and others with low production.

Segregation of production factors is a subject of study from various angles at the present time, but it is generally agreed that the ability of an animal to pass on high production to the succeeding generation is governed by factors which it receives by chance from its parents.

An interesting result of this chance combination of favorable factors in one individual is presented when the offspring of a particular animal show many of the characters of that animal to the exclusion of those contributed by the other parent. We then have existing a condition known as prepotency. Clearly every effort should be made to discover animals prepotent in their transmission of high production.

Prepotent individuals may be of either sex, but in dairy-cattle breeding it is through the bull that we get the quickest improvement.

A dam has only a few offspring and is frequently mated to a single sire, whereas the bull is commonly mated to a number of dams. In choosing a herd sire, therefore, the production records of all his early daughters should be considered.

If all these daughters from different dams are uniformly high producers, it is reasonable to assume that later daughters of this sire will likewise be high producers. Such a bull is said to be a proved sire.

Although it is true that the sons of a prepotent sire may not always produce prepotent animals because of factors for low production received from their dams, continued use of proved sires in the herd should materially raise the probability of obtaining a strain of uniformly high producers.

The question is often raised, What effect does age of the parent have on prepotency?

On this point we must remember that the factors determining inheritance of the offspring are transmitted through the germ plasm of their parents.

Apparently these germ cells are constant in their nature throughout life. No evidence has been brought forth to indicate that a sire or a dam produces one type of germ cell early in life and another type later.

Of course, it is inadvisable to use a bull for service too early, but at 1 year of age he is fully as qualified to stamp his characters upon his offspring as he is 10 years later.

Another phase of breeding is concerned with building up a strain of prolific cows. Unquestionably some individuals and strains are more prolific than others.

In the case of horses and hogs it has been demonstrated that a favorable relationship exists between the number of offspring of mothers and daughters. Adequate information on this point for the cow is still lacking.

One study of a large number of dairy-cow records showed a racial tendency for daughters of highly prolific dams to be less prolific. This would make selection on the basis of the dam alone a dangerous practice.

In selecting breeding stock, pedigrees should be studied in order to obtain animals whose ancestry, in both male and female lines, has been prolific.

Normal growth of calves is one indication of careful selection and breeding. Unfortunately, this is a difficult matter to determine by observation.

Although weights of heifers have occasionally been published in connection with nutritional tests, there is no general set of weights by which the dairy breeder can compare the gain of his own animals with that of the majority of the breed.

In the absence of a general growth standard he should endeavor to derive one for himself. Keeping monthly weights is one way of doing this. If the breeder is so situated that he can secure weights on his animals regularly, they will be valuable in drawing proper conclusions.

When nutritional and other environmental conditions are normal and there is known to be no outstanding defect in the heredity which would check growth, weights recorded monthly over a period of years should have a comparative value and should enable the breeder to find out whether or not the standard of weight increase for his herd is being raised.

A word of caution should be given here. In interpreting normal increase in weight in the herd the influence of heredity must not be confused with that of nutrition. Differences in the quality of pasture in successive years, for example, will result in a difference in growth.

When calves of one year show a rapid gain while on pasture and those of the next year do not measure up to expectations in this respect, the deficiency can not be charged to any breeding shortcoming. Even when normal increase is being attained differences from the average weights can be expected; but when a calf falls greatly below the average the cause should be sought.

If all features in the care of the herd are normal, frequent periodic weights of the calves during several years of calf growing ought to provide a fairly reliable index of the extent to which the quality of normal growth has become fixed in the herd.

Mature size and weight are probably inherited according to a complex scheme.

As in the case of the inheritance of milk production, many different factors may be concerned. This is indicated by gradations, due to segregation, which occur in the second generation following a cross between two animals of markedly different sizes.

This gradation has been observed especially in experiments with animals whose offspring are greater in number than those of the cow.

Segregation may reveal some animals that are larger than the original large parent and others smaller than the small parent, with a series of intermediate sizes.

When this segregation occurs naturally in the herd, it of course permits selection. Thus the mating of the unusually large animals which are the result of segregation should produce only large animals.

Lesson No. 3. Variation in Genetic Make-up of the Cow

M. H. FOHRMAN

Variation is an attribute of living things. To the ordinary observer two or more members of a given species may appear to be alike in every respect, yet detailed examination will reveal hundreds of differences in the characteristics and make-up of even very small organisms. The same unlikeness is discovered to exist among the units which constitute a single part, such as the individual cells of the bones, muscles, or nervous tissue.

It is well to consider this general variation in nature when following the well-known maxim, "Like begets like."

When two purebred Holsteins are mated, the offspring will have the appearance of typical Holsteins, yet no two individuals resulting from such matings will be identical nor will any of the young be exactly the same as either parent.

This variation in the distribution of black and white, or the color pattern, is used as a positive means of identification of animals registered in this breed, and a diagram of the markings is part of the registration certificate.

Therefore, although all registered Holstein cattle are black and white, the Holstein Breeders' Association feels safe in assuming that no two will have the black and white distributed according to the same pattern.

The same is true of white spotting in Jersey and Guernsey cattle. Although it is possible to predict

that the offspring from a given mating may have a coat of broken color, no one would endeavor to foretell the exact amount of white nor where it will be found.

The color of the cow has been used to illustrate variation, because it is visible and can be observed at an early age, but variation exists in all other characteristics governed by the laws of heredity.

The ability of dairy cows to produce milk is a quality which gives them value as dairy animals. Practically all cows inherit this ability; but their relative values depend on the variable degree in which this ability is shown.

The limits of variation in milk production of cattle are not definitely set, but an idea of the possibilities for fluctuation may be obtained by comparing the highest yearly record, 37,000 pounds, which is 9 or 10 times as great as the average yearly production of all cows, with an assumed lower limit of 1,000 pounds. With such a wide range, the possibilities for variation of this quality in inheritance are apparently unlimited.

Although simple unit characters have afforded such effective material for demonstrating the law of probability, it is possible that the very complexity and extreme variation in the milk production of dairy cows may baffle the investigators and screen from their prying eyes the manner in which this quality is passed on from parent to offspring.

We have already assumed that the yearly milk production for all our dairy cows varies from 1,000 to 37,000 pounds. For only officially tested cows of a single breed the limits are about 8,000 and 24,000 pounds, the best cow producing approximately three times as much as the poorest.

It is found that daughters vary as much as 11,000 pounds from their dams even after due allowance has been made for differences in age. Surely in such cases there is slight resemblance between mother and offspring in the ability to produce milk.

Although the dairy sire has no record of his own from which to judge the producing ability of his offspring, it is interesting to observe the variation

which exists in the producing ability of the daughters of bulls.

In studies made of the records of groups of daughters of the same sire, the greatest variability was found in a set of six daughters ranging in production from 8,700 to 20,000 pounds of milk.

Although the average production of the six daughters was only 35 pounds more than that of the dams, yet the record of every daughter varied at least 1,500 pounds from her dam's record.

One daughter exceeded her dam by more than 7,000 pounds, whereas in another case the dam produced about 6,000 pounds more than her daughter.

Another group of 13 daughters of a single bull ranged in production from 8,500 to 23,500 pounds, nine of the daughters differing from their dams by more than 1,000 pounds, one being 8,000 pounds above and another 8,000 pounds below her dam.

Still another bull had 13 daughters, ranging in production from 9,000 to 24,000 pounds.

The best daughter was from the best dam, but the next ranking daughter came from the lowest-producing dam, in which case there was an increase of 8,600 pounds.

So much for variation in half sisters.

In a study made of groups of full sisters, one set of five varied in production by more than 4,000 pounds; a set of four, by 5,000 pounds; a set of three, by 8,000 pounds; and two other sets of three, by more than 5,000 pounds.

Pairs of full sisters were numerous and quite variable. In one case one sister produced 21,000 pounds of milk and the other 12,000 pounds. Another pair varied by 8,000 pounds and three others by more than 6,000 pounds.

In 17 out of 58 pairs of full sisters, one sister was better and the other poorer than the dam. The closest resemblance was in a pair which varied by only 4 pounds of milk.

It is well recognized that part of this variation in milk production is due to environment, which includes feeding, housing, general care, and health of the animals.

Although it might be possible to determine what part environment plays in bringing about variation and then to reduce its effect to a minimum, yet many of these puzzling differences are due to the segregation and recombination of the hereditary factors which govern the function of milk production. This hereditary variability is influenced by the number of factors involved, which have not yet been determined.

If the breeder is to make progress in his work he must give much thought to the selection of his breeding stock and take into account the facts concerning inheritance of milk production.

The sire which transmits high milk production uniformly to his daughters is an invaluable asset to the dairy breed to which he belongs, and his days of usefulness should be prolonged to the utmost. When such bulls are used in succession, each adds his share toward the building of a race of uniformly high-producing dairy cattle.

Lesson No. 4. Systems of Mating Dairy Cattle

M. H. FOHRMAN

The terms "inbreeding," "line breeding," and "outcrossing" by long usage have come to be generally understood as defining the methods of mating practiced by breeders of dairy cattle.

Outcrossing, sometimes called outbreeding, strictly speaking refers to matings where there is no relationship whatever, but as ordinarily used to-day the term is applied to matings where the relationship is less than 25 per cent common blood.

All our pure breeds of dairy cattle have developed from relatively small numbers of foundation animals, and a thorough search of the ancestry of any individual is certain to reveal some relationship, even though distant, between its sire and dam.

The influence of remote ancestors is negligible; consequently the latter meaning of the term "outcrossing," as stated above, is generally accepted.

All animals with some ancestors in common might be called inbred. Inbreeding is concerned, therefore, with a variety of types of matings. To avoid confusion, however, the general practice to-day is to use limiting descriptive terms.

In ordinary usage inbreeding denotes 50 per cent or more ancestors in common. Under this head would come matings of brother to sister, son to dam, and sire to daughter.

Inbreeding as here defined is also called in-and-in breeding or close breeding, to distinguish it from line breeding.

Line breeding as ordinarily defined is a step further away in the closeness of inbreeding and ranges from 25 to 50 per cent common blood. This includes such matings as grandparent to grandchild, cousin to cousin, and nephew to aunt.

Line breeding is the system of mating which has resulted in the development of so-called families in the various breeds of dairy cattle.

Ordinarily the family is composed of the descendants of a well-known individual. Fame as a producer or as a show animal may at any time establish an individual animal as the fountainhead of a new family.

Each of these systems of mating has its advocates and defenders. Although the practice of close inbreeding is generally avoided by present-day breeders, it is nevertheless true that the early development of most breeds of cattle is brought about through close matings.

The reason for this is that the number of desirable animals at the breeders' disposal is so limited that they find it necessary to mate closely related animals in order to establish the good qualities of the breed.

Actual trials with plants and animals have proved the genetic theory that mating of closely related individuals is the surest and quickest way to fix in the offspring qualities of the parent stock. This practice, however, may bring out undesirable traits along with those the breeder is seeking.

Through continuous selection and inbreeding it is possible to eliminate from a race the undesirable characters which are visible in the original stock.

Experiments have demonstrated, however, that latent weaknesses, such as decreased vigor and procreative power, may sometimes result from prolonged inbreeding.

Line breeding is usually advocated as the method of mating which will accomplish many of the desirable results of inbreeding. Although this has not always proved true, the development of distinct families in some of the dairy breeds indicates its popularity.

The mating of individuals of two families is an outcross. Such crosses within the breed are thought to bring increased vigor, size, and prolificacy. Many breeders, however, have preferred to practice line breeding, because of the advantages in advertising which come from linking a breeder's name with a family name of his cattle. As a result, the practice of outcrossing is often neglected where its use might result in more certain progress than the continuation of line breeding. For example, in the use of proved sires outcrossing may frequently be practiced to advantage.

In the breeding of dairy cattle with the primary aim of increasing milk and butterfat production there is no short cut to success, but progress will surely follow the use of animals of known transmitting ability.

Many advocates of line breeding would probably admit that their first substantial forward step came through the use of an outcross bull.

When animals, particularly bulls, of known ability to transmit high-production qualities are discovered, the wise breeder will use them regardless of family or relationship, for there is no reason to believe that factors governing the production of milk and butterfat differ in animals of the same breed regardless of blood lines or family.

Lesson No. 5. Importance of the Dairy Sire

M. H. FOHRMAN

Two dairymen own farms and equipment of equal value and herds of equal size and ability. Both are members of a cow-testing association. Each herd numbers 20 producing cows averaging 5,000 pounds of milk yearly.

Dairyman A has improved his leisure time by studying the producing side of his business.

In the course of his reading he became interested in proved bulls; that is, bulls having a sufficient number of daughters in milk to afford a true measure of their ability as herd sires.

With the help of his cow tester he locates such a bull in a herd similar to his own. This bull has daughters producing a yearly average of 600 pounds of milk more than their dams. The owner sells him this bull because he can not use him any longer without inbreeding.

Dairyman B also needs a herd sire; but although his tester has encouraged him to do so, he has not studied the breeding side of this business and knows nothing about the difference in transmitting ability of bulls. He therefore telephones a cattle dealer who sends him an ordinary bull.

Out of the first calf crop, A and B each raise 5 heifers to be kept in the herd. This is repeated the next two years. Both bulls are then sold, each having left 15 heifers in the herd of his owner, 5 of which are about ready for calving.

In these herds cows are milked about 300 days each year and calve once a year. They also remain four years in the milking herd.

At the end of five years, the records showed that the 15 daughters of Mr. A's bull proved the transmitting ability of their sire by averaging 600 pounds of milk, or about 300 quarts, per year more than their dams.

At 10 cents per quart this amount of milk sold for \$30, and in four years each daughter had earned \$120 more than her dam, making a total of \$1,800 for the 15 daughters, which was mostly net gain.

So he bought another proved bull and enlarged his barn in order to increase his income and perhaps take over some of the business which Mr. B had relinquished. But that's getting ahead of the story.

The first five daughters of Mr. B's bull did their best, but each fell short of her dam's production by about 600 pounds of milk; and with 10 more daughters like these coming along, Mr. B decided that the milk business was a failure. His sons refused to milk poor cows; he complained about the low price of milk, the high cost of feed, unfavorable weather, and the farmers' plight generally. Finally he sold his entire business and went to town.

This story shows why some men have found dairying unprofitable. The dairyman with grades, as well as the breeder of purebreds, finds it essential to give more and more thought to the selection of herd sires as the producing ability of his cows increases.

The continued fame of a herd is based on a wise breeding policy, the basis of which is the choice of bulls which will sire animals superior to or at least equal to those which have gone before.

Mistaken judgment in this one matter has resulted in the abandonment of many well-established breeding businesses and has caused financial loss and worry to other breeders.

To determine the breeding ability of a bull involves some risk on the part of the breeder, because not even all purebred bulls have the ability to increase the production of the daughters over that of their dams.

It is necessary to wait about three years before proof of this ability begins to appear in the offspring. If at the end of that time the bull is found to transmit low production to daughters that have been tested, probably his younger daughters also will be low producers.

Milk-production figures from officially tested cows emphasize the importance of the sire in breeding dairy cattle and the need for better methods of selecting these sires.

After allowance had been made for age differences, more than 600 records of dams and their daughters from one breed reveals the fact that the daughters averaged 11,732 pounds of milk yearly and their dams 11,568 pounds, which is a difference of only 164 pounds.

Fifty-one bulls sired these daughters. The 10 best bulls had 96 daughters whose average production exceeded that of their dams by 1,226 pounds of milk in one year.

In other words, the increase in production of the daughters of the 10 best bulls was more than seven times as much as that of all the daughters of the 51 bulls.

The 10 poorest bulls sired 85 daughters that averaged 1,575 pounds per year less than their dams.

The best bull sired six daughters which averaged 1,928 pounds more than their dams.

The daughters of four other bulls averaged over 1,500 pounds more than their dams.

The poorest bull had seven daughters whose average production fell 3,749 pounds below that of their dams and four others had daughters that failed by more than 1,500 pounds to equal their dams' producing ability.

These figures are even more extreme than the results cited above for the herd sires of dairymen A and B.

The practical dairyman as well as the breeder of purebreds can easily grasp the significance of these figures and the emphasis they place on the importance of the herd sire when breeding for increased milk production.

Lesson No. 6. Selection of the Herd Sire

M. H. FOHRMAN

Continued progress and success in the business of breeding dairy cattle depend largely on the selection of herd sires. One may buy females to add to his herd; but unless he has unlimited financial resources there is slight chance of increasing or even maintaining good average production by depending entirely on purchased females.

The problem of selecting herd bulls requires much attention on the part of most dairymen and of all breeders of dairy cattle. It is a problem as old as constructive breeding itself. And yet it is surprising how little information of real practical value is at hand to guide the breeder in this important work.

The importance of this one seemingly insignificant procedure in the breeding business is shown by the fact that men have reached a high rank as breeders of dairy cattle through the performance of the offspring of a single sire. Unless a second choice is equally wise or fortunate, however, the fame of the herd may dwindle when the great bull and his offspring are no longer in the herd.

Methods of selection as practiced to-day fall into the following classes:

1. Selection by type, based on the conformation of the bull or on his record in the show ring.

2. Selection by pedigree, based on the records of a bull's ancestry. The pedigree shows the breeding of the bull and the performance records of his ancestors for several generations.

3. Selection based on a combination of type and pedigree.

Sires selected by the above methods are mostly young, untried bulls. Whether or not they will build up a successful herd depends on their being able to transmit the desired qualities to their offspring.

In dealing with the problem of selecting the herd sire entirely from the standpoint of production of milk and butterfat, the breeder must first of all look for a sire backed by producing ability. This discards at once the selection by type.

Selection by pedigree appeals to the man who is interested primarily in production.

Such pedigrees give the breeder the production records of ancestors of the bull in question and suggest at least the possibility of similar production from the bull's offspring. Furthermore, the pedigree furnishes good advertising material if the records are large.

This type of selection is the one universally adopted by breeders who practice line breeding.

It is possible by wise and careful choice to build up an excellent pedigree of an individual, which, although telling a truthful story of the ability of his ancestors, may greatly exaggerate the real value of the bull in question.

In examining the pedigree of a prospective herd sire it is well to read carefully all the records given in the first two or three generations, since it is sometimes the practice to include records of individuals with but a slight blood relationship to the bull being considered.

For those with only a limited knowledge of the better strains of the breed, and those unable to travel about in search of a sire, pedigree selection is the best method to follow. In so doing, it is well to insist on a bull from a tested dam. Her record should preferably be a yearly or a 10-month record. If the young bull has any half sisters in milk, their records should be considered also.

The performance records of all the females and the offspring of the male ancestors should be considered, the greatest weight being given to those in the first and second generations.

The contribution of an ancestor in a remote generation to the germinal make-up of an individual is very slight, and his influence in heredity diminishes rapidly with each preceding generation.

One of the pitfalls of straight pedigree selection is the absolute neglect of type. It is true that production pays the bills, but animals of good conformation, including nicely balanced udders, are always pleasing to the eye and will bring better prices when offered for sale than their ill-favored sisters.

This market preference for animals of good breed type is sufficient reason for a thorough study of the conformation of a bull and the type of his dam, half sisters, and other individuals closely related, as well as close inspection of his pedigree, before choosing him as a herd sire.

If he is a young animal, a visit to the farm of the owner will afford a good opportunity of seeing the sire and dam as well as other individuals of the same family. These give a fair indication of what to expect in the offspring when allowance is made for the type of the females to which the new bull is mated.

This is about as far as one can go in the selection of a young bull. Unfortunately, all these external

signs do not fully reveal what is locked up in the germinal make-up of the animal.

Bulls whose pedigrees show high production records and sons of high-producing dams have sometimes failed to transmit production.

Show bulls and animals of good type have frequently produced sons and daughters of only medium ability. Only one way remains to select a herd sire with the assurance that high production will be transmitted to his offspring. This is by the use of a proved bull. His daughters are a true indication of what he transmits to his offspring both as to type and producing ability.

Comparison of the daughters with the dams of those daughters is the basis on which to judge the bull. If the daughters are uniformly better in type and excel their dams in production of milk and butterfat; then their sire may be safely used as a herd leader.

The principal difficulty involved in this method of selection is to find bulls of this kind, because they are at least 5 years old when a sufficient number of daughters have been tested to prove their ability. By this time many of them are no longer available.

Careful study of records and some correspondence and travel are required to locate a proved bull, but to the breeder who has developed his herd to a high point of efficiency this time and expense is an excellent investment. A failure in this important matter of choosing a sire can undo the constructive work of many years.

To summarize briefly in choosing the herd sire:

Select by type if type alone is desired.

When breeding for production, use the pedigree as a basis for choosing a young bull; pay particular attention to the records in the near generations; the more good records in the immediate family the better.

Consider type as well as production and inspect as many of the near relatives of your future sire as possible.

But for greatest assurance in building up the herd choose a bull which has proved himself through the performance of his offspring.

Lesson No. 7. Selecting Dairy Animals by Type

W. W. SWETT

Any breeder of dairy cattle would consider it a great advantage if he could be shown a reliable method of selecting by physical examination animals capable of high milk and butterfat production. It would be particularly desirable if such selection could be made at an early age, in order that only those individuals possessing great ability for production would be raised to maturity.

The livestock show ring is an old institution. Records indicate that cattle have been judged at public shows since 1799. Livestock judging has been taught in our State agricultural colleges for 35 years, and observations have been made by dairy-cattle breeders for hundreds of years.

During the 125-year period of show-ring work with cattle, breeders and observers have given different interpretations to variations in conformation and anatomy or type of dairy animals that have come to their attention. Some undoubtedly have drawn hasty conclusions from observing a few or only a single animal.

Ideas of what constitute ideal type, therefore, have varied and no doubt have undergone changes; yet the underlying principles and the main conceptions of the desirable type of animals for production purposes have remained essentially the same.

The prevailing ideas of type have resulted from the observation and experience of breeders and are reflected from the show ring. They form the basis for instruction in breeding and judging livestock throughout our entire system of education from the boys' and girls' clubs to the State agricultural colleges and universities and serve as a guide for the breeder in making his selections and matings.

Any institution whose teachings are accepted over so long a period is quite sure to be generally sound in principle. Keen observations by livestock breeders through many generations usually will result in the

recognition of many of the desirable characters in their stock.

In classes of livestock whose ultimate purpose is to furnish meat for human food the problem of working out definite standards of type or show-ring ideals should be comparatively simple.

In dairy cattle, however, the problem of developing standards of type which will indicate high milk production is far more difficult, since it deals not only with appearance but also with other inherent qualities which are not visible but which make a cow a good or a poor producer almost without regard to her conformation.

The teaching of dairy type and the judging of dairy cattle in the show ring are based to a very great extent on suppositions. One or two examples will be sufficient to show this.

It is taught that a deep, wide, large, and well-rounded chest is indicative of a strong constitution and is necessary for high production. This in reality is assuming—

(1) That a chest of this character gives a greater space for heart and lungs, or the so-called vital organs.

(2) That this greater space is actually occupied by larger organs.

(3) That the larger organs result in stronger constitution.

(4) That this stronger constitution or vigor is essential for high production.

Again, it is reasoned that a deep, long, wide, well-sprung barrel indicates great digestive capacity and is essential for high production. The assumptions in this case are that the cow with great abdominal dimensions is provided with large digestive organs and that these organs result in the ability to consume, digest, and assimilate large quantities of feed, and, therefore, to produce liberally.

Large nostrils and muzzles are supposed to provide for the intake of a great amount of air and be indicative of strong constitution and desirable if not necessary for high production.

Consultation with prominent anatomists, physiologists, athletic directors, football and track coaches, and leaders in the medical and veterinary professions in this country has shown a wide divergence of opinion regarding these suppositions but little tangible evidence supporting them.

One of our best-known dairymen, who for many years received frequent calls to judge dairy cattle at fairs and shows, almost invariably refused, not because he did not know dairy cattle, but largely because he was unwilling to judge bulls.

We all know that the best type of bull may get daughters that are hopeless as producers. On the other hand, we know that some of the highest producing cows have come from sires that would be considered common in appearance.

Good dairy breeders will seldom, if ever, select a herd sire on the basis of his appearance, although appearance should never be ignored.

You have been told to select a proved bull in order to be sure of obtaining a herd sire capable of transmitting to his daughters the necessary qualities for high production.

Type and pedigree are desirable indications, but proof of performance is far more convincing and profitable in the selection of a herd sire.

Although the possibility of judging the producing ability of the dairy cow is probably much greater than the transmitting ability of the bull, and although a good student of dairy type can undoubtedly select the high producers from the low producers in many cases, yet the best of judges sometimes fail even in selecting cows.

Type and pedigree are important and should never be overlooked. The true worth of a dairy cow, however, lies to a greater extent in her own ability to produce—an ability which must be measured by milk scales and Babcock test.

Much has been done to develop standards of type in dairy cattle, and much is being done to instill into the present and coming generations the ideals that now prevail. It is an important work and worthy of support, but we have much to learn concerning dairy

type, especially as it is related to the performance of the individual.

The Bureau of Dairy Industry is attempting to learn something of the mysteries concerning this significance of dairy type. The importance and desirability of judging cattle is not questioned. We are not criticizing judging, but we believe there is a great deal of supposition in it as it is applied to dairy cattle.

We are not in any way trying to tear down or destroy any of the good work that has been done in establishing dairy type. On the contrary we hope to be able to establish a stronger scientific foundation to support it.

Lesson No. 8. The Significance of Dairy Conformation

W. W. SWETT

Last week we outlined briefly the attempt being made to learn more about the significance of dairy type in the hope that a stronger scientific foundation might be established to support it in theory and in practical application.

One of the fundamentals of this work is a permanent record of the development of the animal. This is partly accomplished by means of photographs taken at regular periods from birth to maturity and at regular periods through mature life.

It is also necessary to measure carefully the body of the animal, thereby translating type into numerical values for purposes of tabulation and analysis.

The photographic record has proved to be particularly instructive. Memory sometimes fails us, but photographs when properly taken do not permit us to forget.

To be useful all photographs must be comparable. By using a camera with a fixed focus mounted on a post which is always at the same distance from the animal, photographs may be obtained which will show the exact change in development taking place from time to time.

To make these photographs even more valuable for comparison, up to 12 months of age all animals are taken against a background lined off in 6-inch squares.

During the early life of the individual, photographs are taken frequently. The first one is secured at about 10 days of age. Following this, photographs are taken monthly up to 6 months, then at 9, 12, and 18 months, and repeated in the early part of each lactation period.

The external body measurements of each heifer are secured at 3, 6, 12, and 18 months of age, and again in the third month of lactation. These measurements include the height, width, depth, and circumference of the animal at different points as well as many other considerations.

One of the most interesting of these is the contour or cross-section diagram which records on paper the exact outline of the body at any point selected and at any age or stage of development. These contours furnish an unlimited source of material for the study of type.

The photographs and measurements have shown emphatically that dairy type or conformation is not only an indefinite thing but that it is subject to radical and rather sudden changes without apparent cause. This tendency to make sudden changes is naturally most common, but by no means limited, to the young, developing animal.

One of the most common and outstanding changes is in the slope or angle of the rump.

A sloping rump is looked upon with disfavor by dairy-cattle breeders. Such a condition surely does not add to the beauty of the animal; and it is a common opinion that other undesirable characters, such as tilted udders, may be associated with it.

The photographs show that an animal may have a rump that is sloping at one time and straight at another; furthermore, that the change may be made in either direction and then reversed, all in the space of a few months and without apparent cause.

Methods for measuring the degree of slope of rump have been devised, and the cause of this condition and its relation to development, shape of udder, breeding

irregularities, producing capacity, and other factors are being studied.

In order to determine the relationship between the external conformation of a cow and her internal make-up arrangements were made with one of the large packing houses whereby investigations were carried on with cows which were selected as they were bought in the yards.

External measurements were made according to the plan just described, the conformations of the animals were translated into numerical values, and all the internal organs and many of the parts were weighed or measured as they went through the slaughtering plant. More than 300 cows were handled in this way.

Analysis of this work is not yet complete, but the great variations in size of organs is easily seen. For example, although the length of body, height at withers, depth of chest, and circumference of chest varied only 28 per cent, 24 per cent, 32 per cent, and 30 per cent, respectively, the weight of blood varied 216 per cent and the weight of lungs varied 315 per cent, the latter ranging from about 3 pounds to more than 13 pounds.

Further study shows a relatively close relationship between *depth* of chest and weight of heart and lungs, whereas the relationship between *width* of chest and weight of heart and lungs is relatively small. In other words, the outside depth of chest appears to be far more important than the outside width of chest as an indicator of weight of heart and lungs. Many other interesting relationships have been shown.

Although the packing-house cows studied were mostly of dairy breeds, the work on these animals can tell only half the story, because it was not possible to secure any information regarding their producing capacity. It permits only a study of the relationship of external form to internal anatomy, or size of organs.

In order to determine the importance of the internal anatomy or size of organs for milk and butterfat production similar work is necessary on cows of known production.

When for any reason a cow is to be removed from the herd of the Bureau of Dairy Industry, it is slaughtered and its internal anatomy is studied in detail. Thirteen of the State colleges and experiment stations are following the same plan in their herds. Already more than 110 cows have been handled. The production of each is known.

When a sufficient number of cows have been handled in this manner, definite conclusions can perhaps be drawn, not only on the relation of outside conformation to internal anatomy but on the relation of internal anatomy to producing capacity.

The following shows another instance of variation in size of organs.

At the Pennsylvania State College, which is one of the cooperators in this work, two cows of the same breed were recently killed. They were within a few pounds of the same weight, almost identical in measurements, and of approximately the same producing capacity. One had 129 feet of intestines, whereas the other had 212 feet. Another cow recently slaughtered had an intestinal tract 244 feet in length.

Since the udder is so closely associated with the production of milk, it seems fitting that special attention be directed to it. It is commonly believed that a large udder is essential for high production.






The quality and capacity of the udder and the importance of the highly developed udder in the calf or young heifer are questions concerning which opinions vary greatly.

The development of the udder from birth to age of first calving, the changes taking place during its secreting stages, its gross structure, and its microscopic structure are all being carefully studied in relation to breeding and producing capacity.



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Dairy Short Course No. 7

DISEASES OF CATTLE

March 25, 1927, to
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*By Specialists of the Bureaus of Dairy Industry
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This is the seventh group of printed lessons supplementing the U. S. Radio Farm School talks from broadcasting stations listed on inside of cover. All regularly enrolled students in the livestock, poultry, and dairy sections will be furnished the full series of booklets.

These publications are mailed at the completion of each short course



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II

DISEASES OF CATTLE

Lesson No. 1. Eradicating Tuberculosis

J. A. KIERNAN

Systematic effort to control and eradicate tuberculosis of domestic animals on a nation-wide scale was begun in 1917 by the United States Department of Agriculture, with State livestock sanitary officials and livestock owners cooperating.

The general campaign of tuberculosis eradication comprises two main projects—the accredited-herd plan and the accredited-area plan.

Methods of Eradication

In the accredited-herd plan herds found to be free from tuberculosis on two successive annual tests are placed on an honor roll, and a certificate is given to the owner by the State and Federal Governments.

Animals of such a herd may be shipped interstate without further tuberculin testing for a period of one year.

Under the area plan of eradicating tuberculosis, a circumscribed area, generally a county, is used as a unit in the work.

Each county generally pays a part of the expense in testing cattle, and part of the cost in cleaning and disinfecting premises.

When not more than one-half of 1 per cent of the cattle in a given area are found to be affected with tuberculosis, such an area is declared to be a “modified accredited area.”

Cattle from those areas may be moved interstate without further tuberculin test.

At several of the larger markets a premium of 10 cents a hundred pounds is paid for hogs from these areas.

Fight the Disease Early

The area plan has become the most popular method of combating the disease. Over three-fourths of the cattle tested during the fiscal year 1926 were tested under this plan.

It is important to remember that the cost of eradicating tuberculosis is greatly reduced by combating the disease in its early stages, yet owners of badly infected herds must not receive the impression that they can not undertake the eradication of the disease with success.

There are records of many herds, in which three-fourths of the animals were affected with tuberculosis, which eventually were freed from it and were afterwards maintained in a healthy condition.

Common Sources of Infection

Tuberculosis may be introduced into a healthy herd in a number of ways, but the contact of healthy cattle with affected animals is without question the most common method of introducing the disease into clean herds.

Dairymen should always be certain that animals purchased are free from the disease. They may be purchased from herds known to be free from tuberculosis or from herds under supervision for the eradication of the disease.

By keeping in mind the different ways in which tuberculosis spreads, the cattle owner may often prevent his herd from contracting the disease.

Besides the danger of infected cows mingling with healthy cows, there are a number of other sources, such as the feed and water supply, from which the germs may enter a clean herd.

Calves contract tuberculosis by nursing, even for a short time, cows whose udders are affected; by drinking raw milk from diseased cattle, or drinking unpasteurized skim milk obtained from a creamery or skimming station.

The Tuberculin Test

It is difficult to detect tuberculosis in cattle by any outward appearances. Even the most noticeable abnormal conditions which sometimes accompany the disease are not always conclusive symptoms of tuberculosis.

The only dependable method of knowing that the disease is present is the application of the tuberculin test.

This operation, as commonly conducted, consists in injecting a small quantity of tuberculin under the skin.

If the animal is affected with tuberculosis, a reaction is produced and is indicated by a swelling near the site of injection or by a rise in temperature.

When tuberculin is injected into cattle free of tuberculosis, no effects follow.

It is important, of course, that this operation be performed by experienced and properly trained veterinarians.

Results of Eradication Work

Since cooperative tuberculosis-eradication work was begun in 1917 more than 29,000,000 tuberculin tests have been applied to cattle. Over 1,000,000 cattle that reacted to the test have been condemned and slaughtered.

A survey conducted during the last year shows that the public is becoming more and more in favor of tuberculin testing as a protection to the health of people. It reveals that 874 cities and towns in the United States have passed ordinances requiring that milk used for human consumption must come from tuberculin-tested cows.

Lesson No. 2. Milk Fever

HUBERT BUNYEA

Milk fever is a disease affecting cows—principally dairy cows—soon after calving. It seldom affects other farm animals.

Cows that have been well fed or overfed and that give a large milk flow are especially susceptible.

Heifers and young cows are less often affected with milk fever than mature cows. Attacks of the disease are most common among cows having the fourth, fifth, or sixth calf.

For many years the direct cause of milk fever was unknown, but it is now believed to be caused by a lack of glucose (a form of sugar) in the blood.

In recent investigations of the disease, the introduction of a glucose solution into the blood of cows affected with milk fever resulted in rapid recovery.

Disease is a Form of Paralysis

Since milk fever is a very common disease in the large dairy districts, a better understanding of its prevention and treatment among dairy farmers is desirable, though actual treatment of affected animals should be performed by a competent veterinarian. A professional man is best able to recognize and treat complicated symptoms, should they arise.

The name of this malady—milk fever—is misleading, since fever is usually absent, and more often there is a reduction in body temperature. The disease is in reality a form of paralysis incident to calving.

Symptoms of the Disease

The malady comes on generally within two days after the birth of the calf and seldom occurs after the second week.

The cow becomes restless, switches her tail, stares around the stall, or walks about uneasily. She may bellow occasionally and show some symptoms of colic.

The signs just mentioned are seldom recognized by the owner, but a few hours later paralysis begins, indicated by a staggering gait in the hind legs and weakening of the knees and fetlocks in front. Finally, the animal goes down and is unable to rise.

While down, the patient assumes a characteristic position that aids in diagnosis.

The head is turned to one side, which is usually the left side, and rests against the chest, causing slight arching of the neck.

The hind legs extend forward and outward in typical cases of milk fever.

A cow affected with this disease pays no heed to her surroundings.

The Air Treatment

The most common method of treating milk fever is the injection of sterile atmospheric air into the udder.

The air treatment is not only simple but is highly effective, and when properly given is harmless.

It is important that sanitary precautions be taken, and for that reason the use of a well-made milk-fever outfit is strongly advised, though some cases have been cured with homemade equipment.

Milk-fever outfits may be obtained from veterinary supply houses and are advertised in leading dairy periodicals.

The administration of medicine by the mouth is not advisable in advanced cases of milk fever on account of the paralysis of the throat and the danger of strangling. An experienced veterinarian can devise suitable hypodermic treatments for such cases.

Preventive Measures

Several precautionary measures are helpful in preventing the development of milk fever.

One is to give susceptible cows plenty of exercise up to the time of calving. The common practice of putting a cow about to calve into a stable tends to invite the disease.

Another practical precaution is to allow a susceptible cow to retain in her udder, for 24 hours after

calving, all the milk except the small quantity required by the calf. If possible, the calf's milk should be taken from each quarter of the udder.

Distention of the udder, which naturally follows as in the air treatment, acts as a preventive against milk fever.

Further information concerning this disease of dairy cows may be obtained from Farmers' Bulletin 206, entitled "Milk Fever: Its Simple and Successful Treatment."

Lesson No. 3. Udder Diseases

HUBERT BUNYEA

There is an old axiom that a horse is no better than his four feet. Translated into dairy-husbandry terms it would sound like this: A dairy cow is no better than her udder.

This rule largely determines the desirability of cows considered for a dairy herd or the fitness of any to remain in a herd.

A cow that is healthy in other respects except that it has a diseased or nonproductive udder is worthless in the dairy herd except as a breeder.

The diagnosis of udder diseases and their treatment call for the services of a trained veterinarian, which, if available, should by all means be obtained, yet by having general knowledge of the principal ailments likely to occur a careful dairyman may do much to prevent trouble.

Prevent the Causes of Udder Troubles

A dairy cow's udder is an abnormally developed gland, resulting from centuries of careful, selected breeding.

Many udder conditions that cause pain and peril to the dairy cow can be avoided.

The first general rule is to make no sharp departure from the regular and established care of the animal.

Failure to milk a cow regularly invites disturbances in the udder, as does, also, unaccustomed exposure to cold, stormy weather.

Prevent, if possible, sources of injury from barbed wire and the bruising or crushing of the teats by other cattle stepping on them, often caused by bad stall construction.

Do not tolerate brutal treatment by attendants who, in driving animals to and from pasture, stone them or beat them.

It is advisable to dehorn all cattle which may inflict injury on others. Such injury may involve the udder as well as other parts of the body.

Avoid attempting to dry off a cow too suddenly before calving. This is especially important when the animal is on succulent pasture or a rich, concentrated ration.

Before drying a cow off it is advisable first to regulate her ration by eliminating concentrates.

Mammitis and Induration

The most common disease of the udder is that known as mammitis, also frequently called garget or inflammation of the udder.

This disease may be due to various causes or a combination of causes, such as exposure to cold or wet weather, bruises, retention of milk, infrequent or irregular milking, the introduction of contaminated instruments into the udder, local infection, or any serious disturbance of the animal's health. It may occur at any time during the milking period, but usually occurs about calving time. The milk is often thin, stringy, and otherwise abnormal.

Another common udder disease is induration or hardening of the udder. This disease is a common result of mammitis and is caused by structural changes in the udder tissue.

Tuberculosis of the Udder

One of the most serious diseases, from the standpoint of the public, is tuberculosis of the udder. This may be distinguished from other udder infections by its gradual onset and chronic course; also by the fact that it rarely causes the animal pain or inconvenience.

The milk secretion appears normal until the infection has progressed considerably, when the milk becomes thin, watery, and scanty and sometimes contains flaky and stringy material. Such milk generally contains tubercle bacilli, thus endangering the health of other livestock as well as human lives.

There is no known cure for this disease.

Other Diseases and Infections

Other udder diseases are gangrene of the udder, cow pox, tumors, stricture (or hard milking), leaky quarter, calculus, suppression of milk, and milk fever.

In addition, the udder is susceptible to infection by abscesses, insect stings, snake bites, wounds, and other causes.

To aid dairymen in preventing the diseases mentioned or to recognize them promptly, the Department of Agriculture has issued Farmers' Bulletin 1422, Udder Diseases of Dairy Cows.

Some of the simpler cases yield to simple home remedies. But it should be remembered that the organ is delicate and complex besides being of vital importance to income from dairying, hence the advisability of procuring the services of a trained veterinarian who understands the physiology of the organ and the effect of various drugs and treatments.

Lesson No. 4. Choke, Bloat, Drenching

T. E. WOODWARD and J. R. DAWSON

Choke

A cow usually chokes from trying to swallow too large an object, such as an apple, potato, or turnip. Choking may occasionally result from the collection of soft feed into a ball. It is most likely to occur in cows that are greedy eaters.

To Detect and Relieve

The animal stops eating, coughs, and saliva runs from the mouth.

When attempting to drink, water runs from the mouth.

If the object is high in the throat, it may be felt as a lump on the left side of the neck and may be forced up into the mouth or crushed by pressing with the hand.

A pint of raw linseed oil or olive oil will aid by acting as a lubricant.

In severe cases a competent veterinarian should be called.

Bloat

Bloat may be caused by any kind of feed which produces indigestion and forms gas in the paunch. Such feeds are young clover or alfalfa pasture, especially if covered with dew; spoiled silage; and roots.

Symptoms and Treatment

The paunch is inflated most noticeably on the left side. In severe cases this distention may extend above the back. When tapped with the fingers the paunch gives a drumlike sound.

When bloat is pronounced, difficulty in breathing is noticed.

Exercise the animal by walking. If this does not help, give a drench composed of 2 tablespoonfuls of liquor cresolis compositus (U. S. P.), mixed with 2 quarts of warm water.

After bloating has subsided, give a drench of 1 pound of Epsom salts in 3 pints of warm water.

If these remedies are not effective and the gas must be allowed to escape without delay, it may be necessary to puncture the paunch. This is best done with a trocar and canula in the hands of a competent veterinarian.

The animal should be fed sparingly on easily digested feed for several days after bloating has stopped, so that all fermenting material may pass out of the stomach.

Drenching

Medicine is usually given to cattle by drenching. This is commonly done by mixing the medicine with

water and giving this by the aid of a long-necked bottle or drenching horn through the mouth.

The medicine should be given slowly to prevent choking.

A simple drenching tube can be made by using an ordinary tin funnel with a piece of rubber hose.

Rules for Drenching

In drenching, care must be used to prevent the medicine from passing down the animal's windpipe to the lungs, causing pneumonia.

In giving a drench the head of the animal should be held in an elevated position and the mouth of the bottle inserted at the side of the mouth in front of the jaw teeth and on top of the tongue.

If the animal coughs, the head should be immediately lowered to prevent the liquid from passing to the lungs.

Care should also be taken to hold the animal in such a way that breathing through the nose is not stopped.

Unless one has had considerable experience in this practice it is best to call a veterinarian, especially if other than ordinary medicines are to be given.

Lesson No. 5. Foul Foot, Nails or Wire in the Stomach, Kicking, Self-Sucking

T. E. WOODWARD and J. R. DAWSON

Foul Foot

This trouble is experienced in many herds. It is thought to be most frequently caused by the animal becoming infected from stable filth while standing in wet, dirty places, or from foreign matter becoming wedged between the toes. The hind feet are most likely to be affected.

The animal seems to suffer when walking on the sore foot, which is inflamed and swollen. When the soreness has advanced, there may be sloughing off of the membrane between the toes, producing an offensive odor.

Treatment

The foot should be thoroughly cleaned, and, if only slightly inflamed, can be washed in a solution of carbolic acid—1 part of pure acid to 20 parts of water.

Cresol compound (liquor cresolis compositus U. S. P.), undiluted, is also good.

The animal should be kept in a clean, dry place.

In persistent or aggravated cases, the foot should be washed well with the above solution and a wad of absorbent cotton smeared with pine tar placed in the cleft. This can be held in place by a strip of strong cloth, 2 inches wide. The middle of the cloth is passed between the toes and the ends wound above the hoof and tied.

The corner of a grain sack, with strips left attached for tying, makes a good outside bandage.

Nails or Wire in the Stomach

On farms where much baled hay or mill feed is used, many cows are killed as a result of sharp-pointed wires or nails puncturing the wall of the stomach, piercing the heart, or setting up infection. The stomach has one compartment in which such material is collected and held. Most of it usually does no harm, but occasionally a sharp-pointed object reaches a vital organ with fatal results.

Some farms use magnets over which all ground feed is passed. Instead of a hatchet or ax, pliers should be used for cutting the wire on the baled hay. Since the pliers sever the wire at one cut, there is less danger of short pieces of wire being broken off and mixed with the hay.

Symptoms and Treatment

When a cow is suffering from a nail or wire coming in contact with the heart, breathing becomes short and is accompanied usually by a gentle grunt at each respiration.

The appetite and general health are also affected, and in severe cases the brisket may become swollen.

The trouble is usually first noticed by general depression and refusal of feed.

Operations to remove the foreign objects have been successfully performed by skilled veterinarians.

The usual treatment consists in keeping the cow as quiet as possible and avoiding the feeding of excessive quantities of roughage. Violent exercise or a greatly distended paunch may push the wire into the heart and cause death.

Kicking

Kicking during milking is largely due to poor management. Many cows will kick when they are being broken to milk, and they must be carefully handled so that they will not form the habit.

Sore or cracked teats will also cause cows to kick.

One should never strike a cow for kicking. Such practice will get her excited and make her worse.

A Good Restraining Method

Some animals must be restrained while being milked. This is best accomplished by placing a heavy strap or rope around the rear legs just above the hocks. Pass this strap around one leg, cross it between the legs, and then pass it around the other leg, drawing them close together. Unless crossed in the middle the strap will slip down when the cow struggles.

Self-Sucking

Every dairyman has had experience with cows that suck themselves. There seems to be no satisfactory explanation as to why they do this.

To prevent the habit, many devices and methods have been tried with varying degrees of success. A device may work successfully with one cow and fail with another.

Preventive Devices

A method that has been used successfully is to fasten one end of a strong stick about 3 feet long to the ring of the halter, passing the stick between the front legs and fastening the other end to a ring in

a strap that extends around the cow's body. This device allows the cow to raise and lower her head but prevents turning her head toward the body.

Muzzles placed over the animals' noses, cradles around their necks, bits in their mouths, and various other methods have been used.

Applications such as quinine or red pepper have been placed on the teats.

If a cow is a confirmed self-sucker, she should be sent to the butcher, unless she is especially valuable as a breeding animal.

Lesson No. 6. Warbles, Lice, and Flies

F. C. BISHOPP

Cattle Grubs, or Warbles

The warble, grub, or wolf of cattle is one of the most injurious livestock pests in the United States. The damage to all classes of cattle has been estimated to be over \$50,000,000 annually.

There are two distinct species of insects involved.

One of these is present throughout practically the entire United States. This is known as the common cattle grub or warble.

The other species is confined at the present time to the two northern tiers of States, and is especially bad in the northeastern part of the country. This form is sometimes spoken of as the "European warble," or "northern cattle grub." It is the more injurious of the two species, and it appears to be spreading.

In general, the life cycle and methods of control are similar for the two species.

The season when the grubs are present in the backs of the animals, and when the flies are active, varies according to latitude.

The Grub's Progress Through the Animal

The eggs are laid principally on the heels and legs of the cattle during the spring and early summer. These hatch in three or four days, and the spiny

maggots burrow through the skin and work upward into the body cavity of the animals.

They are to be found on the surfaces of the various organs in the chest and abdominal cavities for several months, and during the winter or spring they burrow upward to the region of the back, where they complete their growth.

As soon as they reach the back they cut holes through the skin and development of the individual grubs is completed in 35 to 90 days. Then they drop out and change into the heel flies or warble flies 20 to 60 days later.

While laying eggs the flies cause the cattle to run wildly about the pastures. This running reduces milk flow, and lowers flesh condition.

The burrowing of the grubs through the bodies of the cattle has a similar adverse effect, and the hides are seriously damaged by the holes cut by the grubs.

Methods of Control

Farmers and dairymen may lessen the annoyance from the flies by providing darkened sheds or barns for their cattle to enter on days when the heel flies are most abundant.

This class of stock owners can materially reduce the loss from these insects by systematically destroying the grubs in the backs of the cattle.

It is necessary to treat all cattle at monthly intervals for a period of four to five months during the winter and spring.

The grubs can be destroyed either by squeezing them out with the fingers, or with the aid of a pair of alligator forceps, or they may be destroyed by applying nicotine dust containing about 2 per cent of free nicotine or nicotine sulphate.

Very fine tobacco powder, containing about 3 per cent nicotine, will also give a good kill.

Either of these dusts should be applied to the backs of the cattle, taking care to get some of it into each of the grub holes.

Some of the dead grubs will work out of the skin, and others may be removed with ease 10 days after

treatment, although if left in they are not injurious to the animals.

By treating the cattle regularly the grubs which work up from the inside of the hosts are prevented from dropping, and the resulting crop of flies is greatly reduced or eliminated.

Community effort is to be recommended in combating this pest, and, if persisted in, the insects may be completely eradicated.

Lice

There are four different species of lice which attack cattle.

One of these is the red or biting louse, which chews upon the skin scales and moves about considerably.

The other three are blue lice or blood suckers. They are to be found in greatest numbers on the heads, necks, shoulders, dewlaps, and escutcheons of the cattle.

All of the lice breed continuously on cattle, though they are usually much more abundant in winter and early spring than at other times of the year.

The eggs or nits are attached to the hairs, and the young lice remain in groups near where they hatch out.

The period of incubation and of the development of the lice varies somewhat with the different species, each ranging from 10 to 18 days.

Cattle lice do not live long when removed from their host, and they will not breed on other animals than cattle.

How to Destroy Lice

The red or biting lice may be destroyed in all stages by a light dusting of the cattle with commercial sodium fluoride. One ounce per animal is sufficient.

It may be applied with a shaker can, or better, with a geared dust gun. It is irritating to mucous membranes, and should be kept out of the feed and water.

The sucking lice are not controlled by this treatment, but they may be destroyed by standard arsenical solution, kerosene emulsion, or nicotine sulphate, applied as a dip or with a sprayer or mop.

With large herds it is advisable to dip the animals in a vat in the fall.

Raw linseed oil applied when grooming the cattle will also hold lice of all kinds in control.

Since most of the remedies mentioned above are poisonous, the directions on the containers or in the department literature on this subject should be carefully followed.

It is usually necessary to repeat any treatment used two or three times, at intervals of 14 or 16 days, if complete control is to be brought about.

Flies

There are many different kinds of flies which affect cattle, but there are three species, in addition to the warble fly, which are especially troublesome to cattle and about dairies. These are the house fly, the stable fly, and the horn fly.

Checking the House Fly

While the house fly might not be considered as strictly a pest of cattle, it is often annoying to them, and may aid in the transmission of such diseases as pink eye and tuberculosis. Furthermore, it is a pest of decided importance about farm buildings, especially dairies and creameries.

This insect breeds in decaying vegetable matter, and particularly in stable manure. Hence first consideration must be given to proper disposal of manure and other refuse.

The most practical and economical way of disposing of such breeding places is to scatter the refuse thinly on the fields. A manure spreader is recommended for this purpose.

If manure must be stored, it should be placed in a tight shed or pit provided with fly traps to capture the flies which breed out, or it may be stacked up

in compact ricks with vertical sides, or a concrete maggot trap may be constructed.

The treatment of manure with borax at the rate of 1 pound to each 16 cubic feet of manure has also been found to practically eliminate fly breeding.

The use of conical fly traps and the spraying of barns and other out buildings with a good killing spray, such as kerosene-pyrethrum extract, are excellent secondary methods of holding the house fly in check.

The Stable Fly

The stable fly, which is a vicious blood sucker, has breeding habits similar to those of the house fly, but it also breeds extensively in fermenting straw stacks.

Manure should be disposed of as mentioned above, and straw should be stacked so as to keep it from becoming rain soaked; or, better, it should be baled and stored under cover.

The butts of the stacks should be promptly scattered and plowed under.

Stable flies are not caught in numbers in conical fly traps, but the continuous use of fly sprays is a great aid to their control.

The Horn Fly

The horn fly is also a blood sucker, but unlike the stable fly, it remains continuously on the cattle, except for brief moments when it leaves the host to deposit its eggs on the freshly dropped dung. It breeds exclusively in cow manure, whether about barns or on the pastures. This little fly is present throughout the United States, and when abundant, worries cattle day and night.

The scattering of the barnyard manure on the fields is a great aid to the control of this insect. Brush drags may also be used to break up the cow droppings on small pastures.

Fly sprays designed to kill are especially valuable against this species.

In applying the spray, an effort should be made to strike the flies rather than to wet the cattle.

To get best results the animals should be sprayed daily when the flies are numerous, with a sprayer which will break up the material thoroughly and give a good cloud of spray to envelop the flies.

The Screw-Worm Fly

Among other flies which are important cattle pests should be mentioned the screw-worm fly and the horse fly. The screw-worm injury to cattle is confined largely to the Southwest, where the annual loss from it amounts to four or five million dollars.

The flies lay their eggs on any wound, and the maggots immediately enter the flesh, often causing extensive sores.

The black blowfly is a related form which frequently gives trouble after dehorning.

Both of these flies breed in carcasses and other decaying animal matter, and their control depends largely on the destruction of such refuse, preferably by burning.

The systematic trapping of the flies with conical fly traps baited with meat or dried egg is an important supplemental measure.

When animals become infested the worms should be killed with benzol, and commercial pine-tar oil then applied as a repellent.

The Horse Fly

There are many different kinds of horse flies which attack cattle. In regions where there is much swampy land they are very troublesome.

The maggots develop in the mud or gravel, and hence are not easily destroyed.

Killing sprays and darkened barns give some relief, but the main dependence should be placed on the elimination of swampy lands by drainage.

Lesson No. 7. Leading, Restraining, Ringing, and Dehorning Dairy Animals

J. B. SHEPHERD

Leading

Dairy animals should be taught to lead.

Cows and calves properly taught may be easily led by means of a halter made of either rope or leather. Leather halters should have a loose throat strap.

Bull calves should be taught to lead with a halter, but after one year of age they should be led by means of a staff fastened to a ring in the nose.

The bull staff should be strong and preferably made of metal. It should be equipped with a locking device and a hand grip.

If the bull's ring has been torn out of his nose, a special chain or leather halter which tightens across the nose when the lead rope is pulled should be used. Such a bull should be kept in quarters so arranged that he will require very little handling.

Restraining

The common methods of restraining an animal are hobbling, throwing, and the stocks.

In handling a vicious animal it is often advisable to hobble it so that if it starts to run or to make an attack it can be thrown to its knees.

Hobbling

To hobble the animal, put a rope or band about its body just behind the front legs.

Have a loop or ring on this rope or band on either side of the body.

Take another longer rope, and run one end of it through the loop, tying it to the pastern of the front leg.

When the animal starts, a strong, quick pull on this rope will usually bring the animal to its knees.

Throwing Dairy Cattle

Dairy cattle may be gently thrown by the following method:

Use a rope 40 or 50 feet long, depending upon the size of the animal.

Loop one end around the animal's neck and tie with a rigid knot that will not slip. Then take two half hitches around the chest and flank, respectively, being careful that the hitches are well down on the side of the body.

By pulling straight back steadily on the free end of the rope, the animal will fall gently.

If the animal is large, it may be necessary to attach a second rope to one hind foot in order that the animal can be rolled over on its side by pulling this foot from under its body after the animal is down.

Hold the head down and tie the feet so that the rope, which has been drawn tightly around the body, can be slackened.

The Use of Stocks

Stocks are especially useful for holding animals for dehorning, trimming feet, ringing, and other operations. They are strongly built crates or chutes into which the animals are led or driven and securely fastened.

Stocks should be of strong material, well bolted, at least 6 feet high, with an inside width of not over 2 feet 4 inches.

An adjustable rigid stanchion should be provided at one end so that the animal can be securely fastened by the neck.

A heavy iron ring or post to which the animal's head may be tied should be provided in front of the stanchion.

Large or small animals can be accommodated by shifting a heavy timber in slots made for that purpose at the rear of the crate.

Ringling

When the bull is between 8 months and a year old, a ring should be put in his nose. A ring 2 to 2¼ inches in diameter is satisfactory at this time, but at two years of age it should be replaced by a larger and stronger ring.

Rings are likely to wear out with age and use and should be replaced.

In case of an especially unruly bull it is well to put two rings in his nose.

Directions for Ringling

The ringling operation can be done with little difficulty if the bull is properly restrained and his head tied so that he can not jerk.

Grasp his nose firmly with the fingers or a nose lead.

Push a trocar with cannula through the cartilage that separates the nostrils. Then pull out the trocar but leave the cannula.

Put one end of the opened ring in the cannula, then withdraw the cannula, leaving the ring in the nose.

Close the ring and replace the screw.

File the joint until it is smooth.

Do not tie the bull or lead him by the ring until the nose is healed and the soreness gone, which will take from a week to 10 days.

Special nose punches may be obtained if desired for piercing the nose for the ring. Some breeders use a sharp pocket knife for this purpose. There is danger, however, of making too large an incision by this method, and the knife may accidentally close, injuring the operator's hands.

Occasionally a bull pulls the ring out of his nose. In some cases another ring can be placed higher, or the cartilage may be pierced the opposite way and the ring placed in a vertical position. In such cases the ring should be used only for leading the bull, as it may be torn out again.

Dehorning

Horns may be removed by caustic when the calf is a few days old or by sawing or clipping when the horn is either partially or wholly developed. The latter may be done any time after the animal is four months of age.

Either caustic soda or caustic potash may be used. These are in sticks about the size of a lead pencil and may be purchased at any drug store.

To obtain the best results by this method the operation should be performed when the calf is from 4 to 10 days old. At this age the undeveloped horns or buttons are only loosely attached to the skull and appear more as parts of the skin.

How to Use Caustic

The hair should be clipped over and around the horns and grease applied around the edge of the hair. This is done to prevent the caustic from spreading and causing a sore on the skin adjacent to the horn.

The end of the stick of caustic is then slightly moistened and rubbed on each horn alternately three or four times. Each application is allowed to dry before the next is applied.

To prevent the caustic from burning the hands of the operator, the stick should be wrapped in paper with one end exposed.

Care should be taken that none of the solution runs down the side of the calf's head, and the calf should be kept under shelter if there is any likelihood of rain, which would be apt to wash the caustic into the hair and eyes, possibly causing severe burns and blindness.

Removing Horns with Saw or Clippers

After the animal has become too old for the use of caustic, a saw or clipper is commonly used. In this case an experienced man or a veterinarian should dehorn the animal.

Dehorning can be done more quickly and is less painful to the animal with clippers than with the

saw, but in the case of an old animal, whose horns have become hard and brittle, the saw should be used, as it does not crush the horns as do the clippers.

In either case, the horns must be cut close enough to the head so that unsightly stubs will not grow out. From one-eighth to one-half inch of the skin surrounding the horn should be taken off to insure this.

When to Dehorn

Cattle should be dehorned in the late fall, winter, or early spring, when there is little danger from flies.

If there is any possibility of the animal being troubled by flies, coal tar or pine tar thinned with either fish oil or linseed oil should be applied to the wound immediately after the animal is dehorned. This may be done by means of a paint brush or a swab made by tying a rag on a stick.

The dehorned animals should be carefully watched until all danger of infestation by flies is past and the wound is properly healed.

Lesson No. 8. Calf Diseases

By specialists of the Bureau of Animal Industry

Most ailments of calves are caused by improper feeding or sanitary conditions, or both.

Like other young animals, calves need proper feed and attention until they have developed sufficient vigor to withstand adverse conditions.

It is advisable to keep young calves out of cold rains and undue exposure to storms, especially during cold weather.

Provide such natural tonics as exercise, sunshine, pure air, abundance of fresh water, and a variety of wholesome feeds and there will be little need for medical attention. Also keep salt constantly before the calves.

Maintain clean surroundings in pens and yards and provide a comfortable place for calves to sleep.

Common Causes of Scours

Probably the most common disease of calves is scours or diarrhea. It is caused indirectly by one or more of the following practices:

Irregular feeding, overfeeding, sudden change of feed, or feed not warmed to the proper temperature, use of dirty milk pails or feed boxes, and damp, dirty stables.

While this condition may not always presage serious consequences, calf scours is nevertheless a disease which often produces disastrous results.

It commonly affects calves that are from a few hours to two weeks of age and may terminate fatally in from 24 to 48 hours.

When scours is discovered, place all the young calves in individual pens as far as possible to prevent contact with one another.

The pens should receive an abundance of sunlight and be maintained in a cleanly condition, with a liberal quantity of dry bedding.

Precautionary Measures

Newborn calves that are being artificially fed should receive 8 to 12 pounds of their dams' milk daily in three feedings, morning, noon, and night.

To the milk at each feeding may be added one pint of lime water, and the mixture should be fed at a temperature of 100° F.

Two or three ounces of olive oil or mineral oil given to calves shortly following birth, where calf scours prevails, is a good precautionary measure.

Tuberculosis May Affect Calves

Tuberculosis also affects calves—even young calves—though the effects of the disease are seldom visible in young animals.

Calves may become infected by drinking milk from diseased cattle or by nursing, even for a short time, cows whose udders are affected.

When there is any doubt whatever concerning the freedom of cows from tuberculosis their milk should

be heated to a temperature of 145° F. and held there at least 30 minutes before such milk is used for human food purposes or is fed to livestock of any kind.

Since this method requires considerable attention to insure proper heating, boiling milk for a few minutes, when it is intended for calves, is considered a simpler plan.

Calves may become affected with lice and mites. These pests when present in large numbers annoy calves and retard their normal growth and development. This subject is covered in detail in a separate lesson of this series.

Consult a Veterinarian

With proper attention to clean, wholesome feed, and sanitary surroundings calves should remain in good health.

In case disease appears, especially when several calves are affected by an ailment not fully understood, the safest course is to consult a competent veterinarian. The proper use of drugs, the tuberculin test, or surgical treatment all require professional training.

The serious disease, infectious abortion of cattle, also has so much influence on the production of normal, healthy calves that persons interested in raising thrifty calves should become familiar with this subject also.

Farmers' Bulletin 1336, Feeding and Management of Dairy Calves and Young Dairy Stock, gives further details on calf diseases.


Answers to special problems, such as tuberculosis and abortion, are contained in other literature that will be sent on application to the United States Department of Agriculture.




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-
- | Crop | Percentage |
|-------------------------------|------------|
| PASTURES | 40% |
| HAY | 30% |
| COTTON | 10% |
| CORN, WHEAT AND MEAT | 10% |
| DRY LAND RANGE AND IRRIGATION | 10% |

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U.S. RADIO FARM SCHOOL



U.S. DEPARTMENT OF
AGRICULTURE

OFFICE OF INFORMATION—RADIO SERVICE

Dairy Short Course No. 8

DAIRY PRODUCTS

March 25, 1927 to
May 13, 1927



*By Specialists of the Bureau of
Dairy Industry*



U. S. Government Printing Office: 1927

Radio Stations Broadcasting the United States Farm School

(Scheduled on Monday, Wednesday, and Friday, unless otherwise specified)

WGY-----	{ 6.20 p. m., Monday and Friday. 6.45 p. m., Wednesday.
WLS-----	6.15 p. m.
WCCO-----	7.30 p. m.
WOS-----	7 p. m.
KFKX-----	7.15 p. m.
WLW-----	1.40 p. m.
WHO-----	2.15 p. m.
KHQ-----	5.30 p. m.
KMA-----	11 a. m.
KOIL-----	7 p. m., Monday, Tuesday, and Friday.
KQW-----	6.35 p. m.
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WCAE-----	7.10 p. m.
WCSH-----	7.30 p. m.
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WGHP-----	6.40 p. m.
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This is the eighth group of printed lessons supplementing the U. S. Radio Farm School talks from broadcasting stations listed on inside of cover. All regularly enrolled students in the livestock, poultry, and dairy sections will be furnished the full series of booklets.

These publications are mailed at the completion of each short course



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DAIRY PRODUCTS

Lesson No. 1. Preparing Cream for Butter Making

WILLIAM WHITE

To make high-quality butter on the farm it is necessary that the milk be produced under conditions that will insure its having a fine, clean flavor.

Undesirable flavors in the milk, such as those produced by certain feeds or by insanitary methods in handling the milk, are carried into the butter.

The first requisite of good butter, therefore, is good milk.

In preparing to make butter on the farm, the first step is to skim the cream from the milk. This may be done by the old-fashioned method of setting the milk in shallow pans for about 24 hours and then skimming it by means of a hand skimmer.

Cream Separator Desirable

Using a centrifugal cream separator, however, is a better method for several reasons. Nearly all the butterfat goes into the cream, the richness of the cream can be regulated, and the skim milk is available for use while it is fresh from the cow.

A cream separator is desirable even when only a few cows are kept.

The separator should be regulated to deliver cream testing about 30 per cent butterfat, or of such richness that 1 gallon will make about 3 pounds of butter.

In some sections of the country farm butter is frequently made by churning milk instead of cream. This is not a desirable practice, because much butterfat is lost in the buttermilk; a high churning tem-

perature is required, which injures the quality of the butter; and the butter is likely to contain too much water.

Keep Utensils Clean

The thorough cleaning and sterilizing of all dairy utensils is essential to the making of butter of good flavor.

Unclean utensils harbor bacteria that contaminate the milk and cream and develop bad flavors which injure the butter. For this reason it is highly important that the cream separator be thoroughly cleaned and scalded every time it is used.

Churn at Least Twice a Week

Usually several skimmings are accumulated for a churning, though it is best to churn at least twice a week.

If cream is held too long it develops a stale flavor, even though it may not become too sour.

Special care should be taken to prevent the cream from becoming too sour, which has two harmful results—it gives the butter a sour, overripe cream flavor and injures its keeping qualities.

Cool the Cream

When cream is to be held it should be cooled to 50° F. immediately after separation by placing the can in cold water and stirring the cream occasionally with a stirring rod rather than with a spoon or ladle.

Each skimming should be cooled before being added to previous skimmings, as adding warm cream to older cream hastens souring.

If the cream has been kept sweet it should be prepared for churning by ripening it.

Ripening the Cream

About 12 hours before churning time the cream should be warmed to a temperature of 65° to 75° F.,

or to such a temperature that it will be properly ripened, or soured, about two hours before it is to be churned.

A can of cream can be warmed conveniently by setting it in a vessel of warm water and stirring the cream until it is warmed uniformly to the desired temperature. A thermometer is needed, as it is important that a definite temperature be used.

Usually the cream will ripen overnight at about 65° F. in the summer, but in the winter a higher temperature, about 75° F., is needed in order to sour the cream in this length of time.

Preparing Cream for Churning

As soon as it has thickened and is mildly sour it is of the proper ripeness for churning and should be cooled to churning temperature. This may be done, if the cream is in a can, by putting it in a cooling tank and stirring occasionally until the proper temperature is reached.

In order that the butter may have the proper firmness of body, the cream should be held at churning temperature or below for at least two hours before churning.

The correct churning temperature will vary according to several conditions. This subject is taken up in the next lesson.

Lesson No. 2. Churning

WILLIAM WHITE

The question is often asked, What is the proper churning temperature? Unfortunately, there is no one temperature that is right for all times of the year and under all conditions.

The proper churning temperature is that which makes the butter granules come firm but not hard. At such temperature the churning period usually occupies about 30 minutes.

This may seem like a long time to churn, but when churning conditions are such that butter comes in

a very short time the quality of the butter, especially the body, is injured, and there is a much greater loss of butterfat in the buttermilk.

Use of Thermometer Advisable

By using a thermometer to take the temperature of the cream at churning time it is an easy matter to determine just what temperature to use to have the butter granules come firm. Usually this is from 52° to 60° F. in the summer and 58° to 66° F. in the winter.

In the spring, after the cows have been turned out on pasture, if a churning is made at the same temperature that was used during the winter, when the cows were on dry feed, the butter will probably come in a much shorter time and will be quite soft. In such a case the next churning should be made at a lower temperature.

There is No Short Cut in Churning

When churning at too high a temperature, so that the butter comes in about 10 minutes, the butterfat loss in the buttermilk may be five times as great as when the churning period occupies 30 minutes. In addition to this the quality of the butter is injured, because too much buttermilk remains in it, and the body is weak and salvy instead of firm and waxy.

When butter comes soft, it is liable to form in lumps instead of remaining in small granules. The buttermilk in the lumps can not be washed out thoroughly, and as a result the butter does not keep well.

There is no short cut in churning. The churns that get butter in a few minutes produce the same undesirable results as those just mentioned.

Preparing the Churn

After the cream has been ripened and held at churning temperature for at least two hours, it is ready to be put into the churn.

The churn should be prepared for use by rinsing it with scalding water, then with cold water, re-

volving the churn until it is thoroughly cooled before drawing off the water.

The butter ladles, worker, printer, and any other woodenware should be treated in the same way to prevent the butter from sticking to them.

It is a good practice to pour the cream into the churn through a strainer to break up lumps and remove any curd particles or foreign matter.

Have the Churn One-Third Full

In order that the cream may receive proper concussion, the churn should be not more than one-third full.

If too much cream is put in, the churning period is prolonged and the cream in foaming may fill the churn, thereby preventing concussion. If that happens it is best to take out some of the cream.

The Use of Coloring Matter

In the fall and winter it is customary to add some butter color to the cream so that the butter may have the color it naturally has in June. The proper quantity to use must be learned by experience, but usually it is from 20 to 35 drops per gallon of cream.

The cream is now ready for churning.

Directions for Churning

If a barrel churn is used, it should be turned about sixty times a minute or at such speed as to produce the greatest concussion. This can be determined by listening to the sound of the cream swashing in the churn.

After a few turns, the churn should be stopped with the outlet up and the cork removed for a few seconds to permit the escape of gas. This should be repeated once or twice, or until no more gas forms.

When churning begins, the cream produces a very liquid sound and the glass in the churn is evenly covered with cream.

When churning is nearly completed there is a noticeable difference in the sound, and on the glass

a thick, mushy mass appears which occasionally breaks away, leaving the glass clear.

At this point the butter granules are just forming, and the cream has become thick and finely granular, like corn-meal mush, with buttermilk separating slightly from the tiny granules.

At this stage the churning must be watched closely. The churn should be turned a few times, then stopped, and the butter examined, in order to prevent over-churning.

When the granules are the size of wheat the churning is completed. To continue churning until the butter is in large masses is bad practice, because the buttermilk can not be washed out of these masses.

When the churning is completed, the buttermilk is drained off through the hole in the bottom of the churn, a strainer being used to catch any butter granules that may come out with the buttermilk.

Lesson No. 3. Washing, Salting, and Working Butter

WILLIAM WHITE

At the conclusion of the preceding lesson on this subject we told of drawing off the buttermilk, the butter being still in the churn.

While the last of the buttermilk is draining off, the wash water should be prepared.

Preparing the Wash Water

Only pure, clean water should be used. It should be of twice the quantity and about the same temperature as the buttermilk.

A pail or can of water is drawn, its temperature taken with a thermometer and, if necessary, tempered by the addition of warm or cold water.

If the butter granules are too hard, the wash water may be made a few degrees warmer than the buttermilk; if the butter is too soft, the wash water may be made a little colder.

The object of washing butter is to remove the buttermilk. The only way this can be done is to wash the butter when it is in small granules, so that the largest possible surface is exposed to the water.

Trying to remove buttermilk by working it out is not effective. Furthermore, excessive working injures the grain and body of the butter.

The Process of Washing

After the buttermilk has drained off, the cork is replaced in the drain hole, one-half the wash water poured into the churn, the cover fastened on, and the churn revolved rapidly about four times, just as in churning.

Care should be used to avoid overchurning after the water has been put in, as it is desirable to have the butter in small separate granules after the washing is completed. The water is then drawn off and the rest of the wash water poured into the churn.

Two washings are sufficient, the second water usually coming off nearly clear.

While the water is draining off, the worker should be rinsed first with hot water and then with enough cold water to chill it thoroughly.

Directions for Salting

When the washing of the butter is completed it is still in granular condition and is ready to be salted. The quantity of salt to use may be varied to suit the taste, but about three-quarters of an ounce for each pound of butter is customary.

The butter granules are taken from the churn and spread out on the worker about 2 inches thick and the salt, free of lumps, sprinkled evenly upon them, the best grade of butter or table salt being used.

The butter is then worked in order to mix the salt through it and to give it a firm, waxy body.

This is done by pressing it with the lever, care being used to press it only and not to rub or smear it, as this injures the body.

After being pressed into a thin layer it is folded upon itself into a pile and the pressing repeated.

This working is continued until the salt is dissolved and evenly distributed throughout the butter and a waxy body produced.

Importance of Proper Working

The working of the butter is a very important step in the making process and should receive careful attention.

Overworked butter has a sticky and salvy body, a dull, greasy appearance, and gummy grain. It feels warm in the mouth, sticks, and dissolves slowly.

Properly worked butter has a waxy body and bright appearance. It feels cool and dissolves quickly in the mouth.

Butter has the proper grain if a slab breaks when bent at an angle of about 45° , and the broken surface has the appearance of broken steel.

When butter is not worked enough it is brittle, may be gritty because of undissolved salt, and, worst of all, may be mottled or uneven in color.

Butter that is cold and very firm requires more working than that which is comparatively soft. Judgment must be used, however, to avoid overworking it.

The Factor of Feed

There is one factor influencing the body of butter that can not be controlled in the butter-making process, and that is the firmness produced by certain feeds.

When cows are fed a ration made up largely of cottonseed meal the butter is firm, brittle, and greasy, and is said to have a cottonseed-meal body.

Succulent feeds, however, such as pasture grasses, also linseed-oil meal and ground soy beans, tend to produce a soft-bodied butter.

Lesson No. 4. Packages for Butter—Difficult Churning

WILLIAM WHITE

For home use butter is usually made into a roll, known on the market as the country roll, or is packed in glazed earthenware crocks, which are very satisfactory and convenient.

Crocks should not be used if any of the glazing has scaled off, as this permits the crock to absorb butter and buttermilk, which ferment and produce bad flavors that will contaminate butter put into it later.

If butter is to be sold, however, the 1-pound print is a better package. It presents a more attractive appearance than the crock or country roll, is more convenient and easily handled, and can be inserted in a carton, which protects the butter and adds greatly to the appearance of the package.

Directions for Printing

Butter can be printed on the farm by means of the 1-pound hand printer. After some experience in using this simple little machine, 1-pound prints can be made more quickly than country rolls.

The operation is simple and easy. The printer is pressed upon the butter on the worker until it is completely filled; the surplus is then cut off with a paddle and the print pressed out on the parchment wrapping paper.

The printer can be regulated so that the print of butter will weigh exactly 1 pound, but it is necessary, of course, to avoid air pockets, and it is good practice to weight an occasional print to be sure the weight is correct.

Wrapping and Labeling

Prints for market should be wrapped in white 8 by 11 inch parchment paper made for this purpose. They should be put in paraffined cartons upon which may be printed the name of the farm or brand.

The net weight should also be stated. This is required in some States and for interstate shipments.

After being printed and wrapped the butter should be put in a refrigerator or other cool place.

The churn, worker, and other utensils should be thoroughly cleaned by using a hand brush, hot water, and dairy cleanser, then rinsed with scalding water.

Causes of Difficult Churning and Remedies

The farm butter maker sometimes fails to obtain butter after churning the usual length of time; in fact, the churning is sometimes prolonged for several hours without obtaining butter.

The causes of the difficulty, together with the remedies, are as follows:

1. Churning temperature too low. It may be necessary, under exceptional conditions, to raise it to between 65° and 70° F.

2. Cream too thin or too rich. It should contain about 30 per cent butterfat.

3. Cream too sweet. If ripened to a moderate acidity it will churn more easily.

4. Churn too full. In order to obtain the maximum concussion the churn should be not more than one-third full.

5. Ropy fermentation of the cream preventing concussion. This may be avoided by sterilizing all the utensils and producing the milk and cream under the most sanitary conditions. If additional measures are needed, the Pasteurization of the cream, with subsequent protection from contamination and ripening it with a good starter, will be effective.

6. Individuality of the cow. The only remedy is to obtain cream from a cow recently fresh, or cream that is known to churn easily, and before ripening mix it with the cream that is difficult to churn.

7. The cow being far advanced in the period of lactation. The effects may be at least partially overcome by adding, before ripening, some cream from a cow that is not far advanced in the period of lactation.

8. Feeds that produce hard fat. Such feeds are cottonseed meal and timothy hay. Linseed-oil meal,

gluten feed, and succulent feeds, such as roots, tend to overcome the condition.

Lesson No. 5. First Steps in Cheese Making

WILLIAM WHITE

Making American cheese is not nearly so common a practice on the farm as making butter. Cheese is more difficult to make than butter and also requires more time.

Because the market requires a uniform product, it is not as a rule desirable to make farm cheese to be shipped to market.

Cheese for home use, however, can be made wherever a supply of fresh, clean milk is available.

The Time Required

The time required to make cheese is about five or six hours from the time the milk is placed in the vat for heating until the cheese is put into the hoop for final pressing, but during that time it is not necessary for a person to give it his entire attention.

From this point until the end of two weeks, only a few minutes are required each day to turn the cheese. After that time it is turned only twice a week until fully cured.

100 Pounds of Milk Produces About 10 Pounds of Cheese

Approximately $10\frac{1}{2}$ pounds of cheese is obtained from 100 pounds, or $11\frac{2}{3}$ gallons, of milk containing 4 per cent butterfat.

The higher the butterfat content of the milk and the smaller the quantity of solids lost in the process of manufacture, the greater the yield of cheese.

A cheese of any size may be made.

Use Only Fresh, Clean, Whole Milk

Only whole milk should be used, as skim-milk cheese made by this method is hard, dry, and lacking in flavor.

It is important to have fresh, clean milk for cheese making. If milk is to be kept overnight it should be cooled immediately to a temperature of 60° F. or lower and held at that temperature until used. The milk should not be held more than 12 hours, as it is very essential that the milk be perfectly sweet.

Regular Cheese Vat Preferable

Small quantities of cheese may be made in a wash boiler, large kettle, or tub, but if it is to be made frequently or on a fairly large scale a regular vat is more satisfactory, as it is constructed with a jacket or compartment in which hot or cold water may be placed for regulating the temperature of the milk.

A Thermometer Necessary

The control of temperature throughout the making process is essential to successful cheese making. A good thermometer is therefore a very necessary piece of equipment. A floating dairy thermometer is the most convenient kind to use.

In starting the process of cheese making the milk is put into the vat or the receptacle to be used as a vat and heated to 86° F., which is a temperature favorable for the changes that are to occur in the milk during the first stages of cheese making.

Coloring Improves Appearance

If it is desired that the cheese be a deep shade of yellow, coloring matter should be added to the milk. Uncolored cheese is light yellow or straw color.

Although its flavor is not improved by the addition of color, many people prefer the appearance of cheese that has a deep yellow color.

Commercial cheese color, such as is sold by dairy supply houses, should be used.

The quantity of cheese color required to produce a desirable shade is from one-half to 1 teaspoonful to 100 pounds of milk. The color should be stirred thoroughly into the milk.

Curdling Agents

Rennet extract is used to curdle the milk and may be obtained from dairy supply houses. It should be added at the rate of 2 teaspoonfuls for each 100 pounds of milk.

The rennet should first be mixed with a pint of cold water and then stirred into the milk very thoroughly, the stirring being continued about three minutes.

If rennet extract is not obtainable, junket tablets may be used. These may usually be obtained at drug stores. About $3\frac{1}{2}$ tablets are required for each 100 pounds of milk. They should be dissolved in 7 tablespoonfuls of cold water and then added to the milk in the same manner as rennet.

After the rennet has been stirred in, the milk must stand undisturbed until curdled. If there is the slightest motion to the milk while curdling the curd will not be firm.

Proper Temperature Important

It is very important that the temperature of the milk at this time be 86° F., and that it remain at this temperature until a firm curd has formed, which should be in 30 to 35 minutes, depending upon the quantity and strength of the rennet used and the freshness and other qualities of the milk.

The vat should be covered to keep the surface of the milk from cooling.

As soon as the curd is of the proper degree of firmness it is cut into small pieces.

Determining Proper Stage for Cutting

If the curd is cut when too soft it will be broken up, resulting in a loss in yield, or if allowed to get too hard it will be cut with difficulty.

The usual method of determining the proper stage for cutting is to insert the forefinger in the curd at an angle of 45° and about one-half inch under the surface. The finger is then raised slightly and the curd split with the thumb.

If the curd splits smoothly without leaving particles on the finger it is ready to be cut.

Special curd knives may be obtained for cutting it into cubes of equal size. Uniformity in the size of these cubes is necessary to insure uniform firming of the curd.

Directions for Cutting

The curd should first be cut lengthwise of the vat with a horizontal curd knife, then crosswise with a vertical knife, and finally lengthwise with the vertical knife, thus leaving the curd in small cubes.

To insure a maximum yield of cheese it is necessary to avoid crushing the curd or breaking it into very small pieces. The curd knives should be inserted and removed from the curd in such a way as to cut it rather than to crush it.

If curd knives are not available the curd may be cut with a large butcher knife into three-eighths-inch cubes. The curd should be cut both lengthwise and crosswise of the vat, and then, after carefully giving the curd a quarter turn so that one side is now on the top, cut lengthwise again.

Lesson No. 6. Continuing the Cheese-Making Process

WILLIAM WHITE

In the preceding lesson on cheese making the milk was curdled with rennet and the curd cut into small pieces.

As soon as the curd is cut it should be stirred in order to prevent the pieces from sticking and forming large lumps.

The cubes of curd contract slowly and expel whey. As soon as a considerable quantity of whey is separated from the curd, usually in about 15 or 20 minutes, heating should be started.

It is very important to raise the temperature very slowly—at the rate of about 2° in five minutes—until a temperature of 100° F. is reached.

During the entire heating process the curd should be stirred just enough to keep the small cubes from matting together,

The curd should remain in the whey at a temperature of 100° F. until it is firm and sufficiently acid.

Determining Proper Degree of Firmness

The proper degree of firmness of the curd may be determined by pressing a mass of it gently between the hands for an instant.

If when suddenly freed from pressure the pieces fall apart at once and show no tendency to stick together, the curd is of the proper firmness. At this stage the cubes have contracted to about one-half the size they were originally.

If the curd becomes too firm, the cheese will be dry and corky. On the other hand, if the curd is not firm enough, the cheese will be soft, too moist, and likely to sour.

The Acid Content Important

The amount of acid which is allowed to develop in the curd before removing the whey is a very important step in the cheese-making process.

While in the whey, the curd should be watched closely to prevent the development of too much acid, which produces a dry, mealy cheese with a sour flavor. On the other hand, a curd with too little acid is likely to develop gas and bad flavors during the curing process and does not keep well.

How to Test for Acid

The proper amount of acid to develop in a curd before removing the whey may be determined by pressing a little curd in the hand, gently at first but with increasing firmness, for about a minute, or until the particles adhere and moisture is expelled.

This piece of curd is rubbed gently on a clean, hot iron until it adheres and is then very slowly and carefully pulled away from the iron.

If in doing this, fine, silklike threads $\frac{1}{4}$ to $\frac{1}{2}$ inch long are formed, the whey should be removed.

The iron should be just hot enough so that the curd will stick to it and not burn the fine threads.

If threads do not form, sufficient acid has not yet developed, and the curd should be left in the whey to permit the development of acid. During this period occasional stirring is required to prevent matting.

Removing the Whey

As soon as the curd is firm and the proper amount of acid has been developed, the whey should be removed.

The curd is allowed to settle, the free whey is dipped off, and the curd is then placed on a rack to drain.

While on the draining rack the curd should be stirred continuously until all the free whey has escaped; after that it should be stirred every 5 or 10 minutes to prevent it from matting together and to keep it broken into pieces of the size of a large hickory nut.

The curd should be kept warm and as near 100° F. as possible to permit the development of acid.

If only a small amount of cheese is to be made, a large kettle or dish pan may be used for draining the curd.

A rack can be made to fit these receptacles, with a space underneath the rack which will serve as a reservoir for the whey that drains from the curd.

In case a vat is used for making cheese, no draining racks will be needed. The whey is drawn off through the faucet provided for that purpose. The draining and other operations necessary before the curd is ready to be pressed are completed in the vat.

Salting the Curd

The stage for salting the curd is determined by the hot-iron test.

When the curd shows fine, silklike threads from $\frac{3}{4}$ to 1 inch in length when rubbed on a clean, hot iron, the salt should be added. About 3 ounces of salt for each 10 pounds of curd is sufficient.

After the salt has been thoroughly stirred through the curd it should be allowed to dissolve and the curd allowed to cool to a temperature of about 85° F. before it is put into the press.

Specifications for Home-Made Cheese Press

A suitable cheese press can be made easily and quickly by means of a piece of timber 2 by 4 inches and 12 feet long, used as a lever.

One end should be fixed at a suitable height, about 3 feet above the ground or floor, and the cheese placed on a bench under the lever and about 3 feet from the fixed end.

Pressure can then be applied to the cheese by attaching a weight to the lever near its free end.

An old tin pail full of stones weighing 35 to 40 pounds makes a convenient weight, as it can readily be moved along the lever toward the free end to increase the pressure on the cheese.

A hoop or mold for pressing the cheese can be made from galvanized-metal sheeting, the most convenient size being 7 or 8 inches in diameter and 10 inches in height. A wooden bottom should be made to fit inside the hoop and a number of three-sixteenths-inch holes bored in it to allow the whey to escape.

Cheese hoops may be obtained from dairy supply houses. One making a cheese of from 5 to 10 pounds is suitable for farm use.

Lesson No. 7. Pressing and Curing Cheese

WILLIAM WHITE

At the end of Lesson 6 on cheese making the curd was ready to be put into the hoops for pressing.

Before putting in the curd, however, the hoop is lined with cheesecloth, which is to be left on the finished cheese. This aids in the formation of a good rind and improves the appearance of the cheese.

Preparing the Hoop

The cloths for this purpose are of two patterns—circles of the diameter of the cheese for the top and bottom, and a bandage made from cheesecloth in the shape of a sleeve that will fit very snugly into the cheese hoop.

In preparing the hoop for the curd a circle of cloth is placed in the bottom. The bandage then is put in with the seam on the inside, overlapping on the bottom about 1 inch, and extending high enough so that it can be turned over the upper edge of the hoop and held in place.

Pressing the Cheese

After the salt is dissolved and the curd cooled to 85° F. it should be put into the hoop and pressed.

Pressure should be applied gently at first in order to avoid squeezing butterfat out of the curd. To do this a weight should be placed on the lever of the press about halfway between the cheese and the end of the lever.

After half an hour the weight should be moved to the end of the lever and allowed to remain about an hour. Then the cheese should be taken out and dressed.

Method of Dressing

To dress a cheese it is first removed from the hoop and dipped in warm water. The cloth circles are then removed from both ends and all wrinkles drawn from the side bandage.

The end circles are then replaced and the cheese again wet with warm water to aid in the formation of a good rind.

The side bandage should not be removed at any time during the dressing or curing process.

After the cheese has been properly dressed, it should be put back into the press and full pressure applied for 24 hours.

After it has been taken from the press the cheese is removed to the curing room, where it is placed on a shelf and turned over every day until it is 2 weeks old, when it should be paraffined.

After the cheese has been paraffined it need not be turned but twice a week.

The Process of Curing

Curing is an important part of cheese making. Both the temperature and humidity should be under reasonable control.

If properly ventilated a cellar is probably the best place during hot weather for curing cheese on the farm.

If it is desired to cure cheese quickly, it may be kept at a temperature of 65° or 70° F., but a temperature of 50° to 60° F. is regarded as the most favorable.

Should mold appear on the cheese, the shelves should be wiped with a dry cloth when it is turned.

If the cheese molds badly, it should be scrubbed with strong brine and placed in a drier curing room.

The Use of Paraffin

Paraffining cheese prevents mold from growing on the surface and also greatly retards the evaporation of moisture.

A convenient way to paraffin cheese on the farm is to heat the paraffin to a temperature of about 220° F. in a receptacle of suitable size, roll the cheese in the hot paraffin for two to four seconds, then dip the top and bottom for the same length of time, thus coating the entire surface.

The paraffin must be hot or it will not penetrate the rind of the cheese, but will form a thick coating that will easily crack and peel off.

Keep Flies Out of Curing Room

Great care should be taken to keep flies from the curing room. All windows should be covered with cheesecloth. Screen wire does not answer the purpose, as the fly which damages cheese by causing skippers is smaller than the ordinary house fly and can easily pass through the meshes of the screen wire commonly used.

Cheese may be cured enough to be eaten when 6 weeks old. The flavor, of course, is then quite mild.

If an even, low temperature is provided for curing the cheese it will cure slowly, and if a sharp flavor is not objectionable the cheese may be kept for many months.

The manufacturing process and the temperature of curing the cheese may be modified to produce either a fast-curing or a slow-curing cheese.

Conditions Necessary for Quick Ripening

When it is desired to have a cheese ripen quickly, the curd should contain somewhat more moisture and therefore not be quite so firm when put into the hoop, less salt should be used, and less acid should be developed in the curd at the time of salting.

As mentioned in a previous lesson, the amount of acid in the curd is measured by the hot-iron test.

For a quick curing cheese the threads on the hot iron should not be more than one-half inch long.

The temperature of the curing room should be kept between 65° and 70° F.

To Ripen Cheese Slowly

When it is desired to have cheese ripen slowly the curd should be quite dry and firm when put into the hoop, it should be more highly salted, and more acid should be developed in the curd at the time of salting. On the hot iron threads should form about 1 inch long.

Curing for Future Use

Cheese may be made during the summer and, especially in the Northern States, kept for use throughout the winter.

When the cheese is to be kept for such a long time it should be cured at the lowest temperature available on the farm, and as the weather becomes cooler in the fall the cheese should be kept at a temperature as near the freezing point as possible. It should not, however, be permitted to freeze.

Cheese a Valuable Food

The farmer and his family lead an active, vigorous life; and they must be especially well nourished to meet the requirements of farm work. Cheese furnishes muscle and body-building material in abundance, and with a supply of milk for cheese making on the farm there is no reason why the farmer should not have this good food on his table.

Lesson No. 8. Making Cottage Cheese on the Farm

K. J. MATHESON

Cottage cheese furnishes a convenient and economical means of using skim milk as a human food. It is easily made, requires no special equipment, and is a highly palatable and nutritious product.

Ordinarily the cheese is eaten when freshly made, although it may be kept several days in a cool place.

Milk which is clean and has been well cared for is placed in a pail or shotgun can, warmed to 75° F., and allowed to stand at this temperature until curdled.

For uniform results a thermometer should always be used.

One gallon of skim milk will make about 1½ pounds of cheese.

Ripening the Milk

An essential step in the making of cottage cheese is to sour or ripen the milk.

If care has been exercised in the production and handling of the milk, a good grade of cheese may be made by allowing the milk to sour naturally; however, more definite and uniform results may be obtained by the use of a starter.

Starters aid and hasten acid fermentations and tend to suppress undesirable fermentations.

A homemade starter is obtained by allowing desirable acid-forming bacteria to grow in a quantity of milk until it contains a great number of these bacteria, which cause the milk to become sour. About a cupful of starter or good sour milk is sufficient, although more or less may be used.

Time Required for Curdling

The length of time required for curdling depends upon the freshness of the milk and upon whether or not a starter has been used.

With a starter the skim milk will curdle in 10 or 15 hours, whereas without a starter fresh milk may

not curdle for 24 hours or even longer. Increasing the quantity of starter will reduce the curdling period.

During the setting period no special attention is required.

When a smooth, firm curd has been formed it is ready for cutting.

Cutting, Heating, and Stirring

The curd is cut crosswise into 1 or 2 inch squares with a long-bladed knife. The temperature of the mixture of whey and curd particles is then raised to about 100° F. and the mass stirred at intervals for about half an hour.

Stirring and heating gradually reduce the size of the curd particles until they are a little smaller than that of a pea, in which condition the curd is ready to drain.

The degree of heating, the size of the curd particles, and the acidity developed largely determine the texture of the cheese.

Draining

Following the heating, the curd is poured upon cheese cloth and allowed to drain into a pail or other receptacle for 15 to 20 minutes. The curd should be undisturbed during this period, otherwise it tends to become mushy, a condition which renders the removal of the whey more difficult.

After this preliminary draining, the sides of the cloth should be raised and lowered several times, thereby hastening the expulsion of the whey.

Drainage should continue until very little whey separates upon standing. In this condition it is ready for salting.

Opinions differ as to whether a dry or a moist cheese is most desirable.

Salting

The cheese is now salted to suit the taste. A little over one teaspoonful of salt is ordinarily required for each pound of curd.

Salt is sprinkled upon the curd and worked in by means of a spoon or paddle.

The cheese is now ready to eat.

Making Cheese with Rennet

Cottage cheese made with rennet or junket tablets has a fine and uniform texture.

The process of making is the same as already described, except that two or three drops of liquid rennet, diluted in a tablespoonful of cold water, is stirred into the milk.

If no starter is used, it is best to allow the milk to stand several hours at about 80° F. in order that it may ripen slightly.

When rennet is not available, one-eighth of a junket tablet should be dissolved in a small quantity of cold water and added to each gallon of milk.

After the milk has coagulated from the use of either liquid rennet or junket tablets, it is poured directly upon the drain cloth without cutting or heating. A fine and heavy draining cloth is necessary because of the fineness of the curd.

After a short preliminary draining, the ends of the cloth are drawn together, tied, and the curd subjected to a slight pressure sufficient to bring it to the desired consistency.

Pasteurization of the Milk

It is desirable, although not always practical, to Pasteurize the milk for cottage cheese. This treatment makes it possible to control the fermentation, to increase the yield, and to render the product free from disease-producing organisms.

If the milk is Pasteurized just before use, it is absolutely necessary to use a starter.

Quality

Cottage cheese is judged by its flavor and texture.

A good quality of cheese should have a clean, mild-acid flavor, and a smooth, soft texture, free from lumps, and be uniform or homogeneous throughout.

Flavor can be controlled by the use of a clean, sweet skim milk and a good starter, but texture depends largely upon careful manipulation during the making process.

The palatability of the product is improved by the addition of a small quantity of sweet or sour cream.

If the cheese is to be kept for several days, it should be stored in an earthenware or glass vessel rather than in one of tin or wood. It should be stored in a cold place so that it will keep longer without becoming sour or moldy.



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